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Cladocera (Crustacea: Branchiopoda) of the south-east of the Korean Peninsula, with twenty new records for Korea*

ALEXEY A. KOTOV[1,2], HYUN GI JEONG[2] & WONCHOEL LEE[2]

[1] *A. N. Severtsov Institute of Ecology and Evolution, Leninsky Prospect 33, Moscow 119071, Russia*
E-mail: alexey-a-kotov@yandex.ru
[2] *Department of Life Science, Hanyang University, Seoul 133-791, Republic of Korea*

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Abstract

We studied the cladocerans from 15 different freshwater bodies in south-east of the Korean Peninsula. Twenty species are first records for Korea, viz. 1. *Sida ortiva* Korovchinsky, 1979; 2. *Pseudosida cf. szalayi* (Daday, 1898); 3. *Scapholeberis kingi* Sars, 1888; 4. *Simocephalus congener* (Koch, 1841); 5. *Moinodaphnia macleayi* (King, 1853); 6. *Ilyocryptus cuneatus* Štifter, 1988; 7. *Ilyocryptus cf. raridentatus* Smirnov, 1989; 8. *Ilyocryptus spinifer* Herrick, 1882; 9. *Macrothrix pennigera* Shen, Sung & Chen, 1961; 10. *Macrothrix triserialis* Brady, 1886; 11. *Bosmina* (*Sinobosmina*) *fatalis* Burckhardt, 1924; 12. *Chydorus irinae* Smirnov & Sheveleva, 2010; 13. *Disparalona ikarus* Kotov & Sinev, 2011; 14. *Ephemeroporus cf. barroisi* (Richard, 1894); 15. *Camptocercus uncinatus* Smirnov, 1971; 16. *Camptocercus vietnamensis* Than, 1980; 17. *Kurzia* (*Rostrokurzia*) *longirostris* (Daday, 1898); 18. *Leydigia* (*Neoleydigia*) *acanthocercoides* (Fischer, 1854); 19. *Monospilus daedalus* Kotov & Sinev, 2011; 20. *Nedorchynchotalona chiangi* Kotov & Sinev, 2011. Most of them are illustrated and briefly redescribed from newly collected material. We also provide illustrations of four taxa previously recorded from Korea: *Sida crystallina* (O.F. Müller, 1776); *Macrothrix rosea* (Jurine, 1820); *Bosmina* (*Bosmina*) *longirostris* (O. F. Müller, 1776) and *Disparalona cf. hamata* (Birge, 1879). Among the newly recorded taxa, there are six Far East endemics; five tropicopolitan species for which the Amur basin is the northernmost margin of their distribution; four tropicopolitan species for which Korea is presumed to be the northern most area of their distribution; two Palaearctic taxa for which Korea could be the southern most area of their distribution; two cosmopolitan species which need to be revised; and one species widely distributed in Eastern Asia. Despite significantly increasing the number of known species of cladocerans in Korea, we recognize that further research is needed to complete the picture, and the cosmopolitan taxa need further revision.

Key words: New records, taxonomy, cladocerans, freshwater, biodiversity, South Korea

Introduction

During the last two decades, significant progress was achieved in the study of some genera of Ctenopoda (Korovchinsky 2004), Anomopoda (Smirnov 1992, 1996, 1998; Kotov & Štifter 2006; Van Damme & Dumont 2008; Kotov 2009; Sinev 2009; Van Damme et al. 2011) and Haplopoda (Korovchinsky 2009) based on "traditional" morphological analysis. Phylogeographic studies based on molecular methods (Adamowicz et al. 2009; Xu S. et al. 2009; Xu L. et al. 2011) also contributed to our understanding of the taxonomy, but unfortunately they were (and are) conducted only for few, mostly planktonic, genera. Some attempts to combine morphological and molecular approaches were made, but such publications are still rare (Belyaeva & Taylor 2009; Kotov et al. 2006, 2009).

Improvements in the taxonomy of cladoceran groups need to be accompanied by studies of regional faunas conducted according to current standards, as done by Alonso (1996) for the Iberian Peninsula. Unfortunately, such investigations are mainly limited to the Holarctic, even though spectacular progress has been made in tropical countries like Mexico (Elías-Gutiérrez et al. 2008), Brazil (Elmoor-Loureiro 2000) and Thailand (Maiphae et al.

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2008). But many other territories need to be re-studied, and the Korean Peninsula is among them. The first records of Korean Cladocera were made by Japanese limnologists (Uéno 1941; Yamamoto 1941, 1944). After a long period of inactivity, Kim (1988), Yoon & Kim (1992, 1993, 1995, 1997, 2000a–b) and Yoon et al. (1996) published a series of papers about selected genera. Finally, Yoon (2010) summarized information and gave short descriptions of 55 species. Starting our program for the study of the cladocerans in the Republic of Korea, we doubted that this list was complete, keeping in mind that the total diversity of the cladocerans in the Palaearctic is at least 245 species (Forró et al. 2008). In addition, the Far East of Russia recently became an important source of new taxa in different families (Kotov et al. 2006, 2011a,b; Kotov & Sinev 2011; Korovchinsky, 2009; Smirnov & Sheveleva 2010), with the localities of newly described "Russian" taxa only about eight to nine hundred kilometers from the region studied here.

The aim of this study was to document new cladoceran records for Korea, based on an examination of samples from the south-east of the country.

Material and methods

Analogous papers normally contain a table summarizing information on presence of different taxa in different localities, but we avoid providing such a table. In the course of present study, only some localities were systematically sampled using a uniform method, while other localities were represented by subsamples of sorted specimens, or by exclusively limnetic samples, which are inadequate for estimating the diversity in these water bodies. Only localities where new records for Korea were found are presented in Table 1, Fig. 1. For identification,

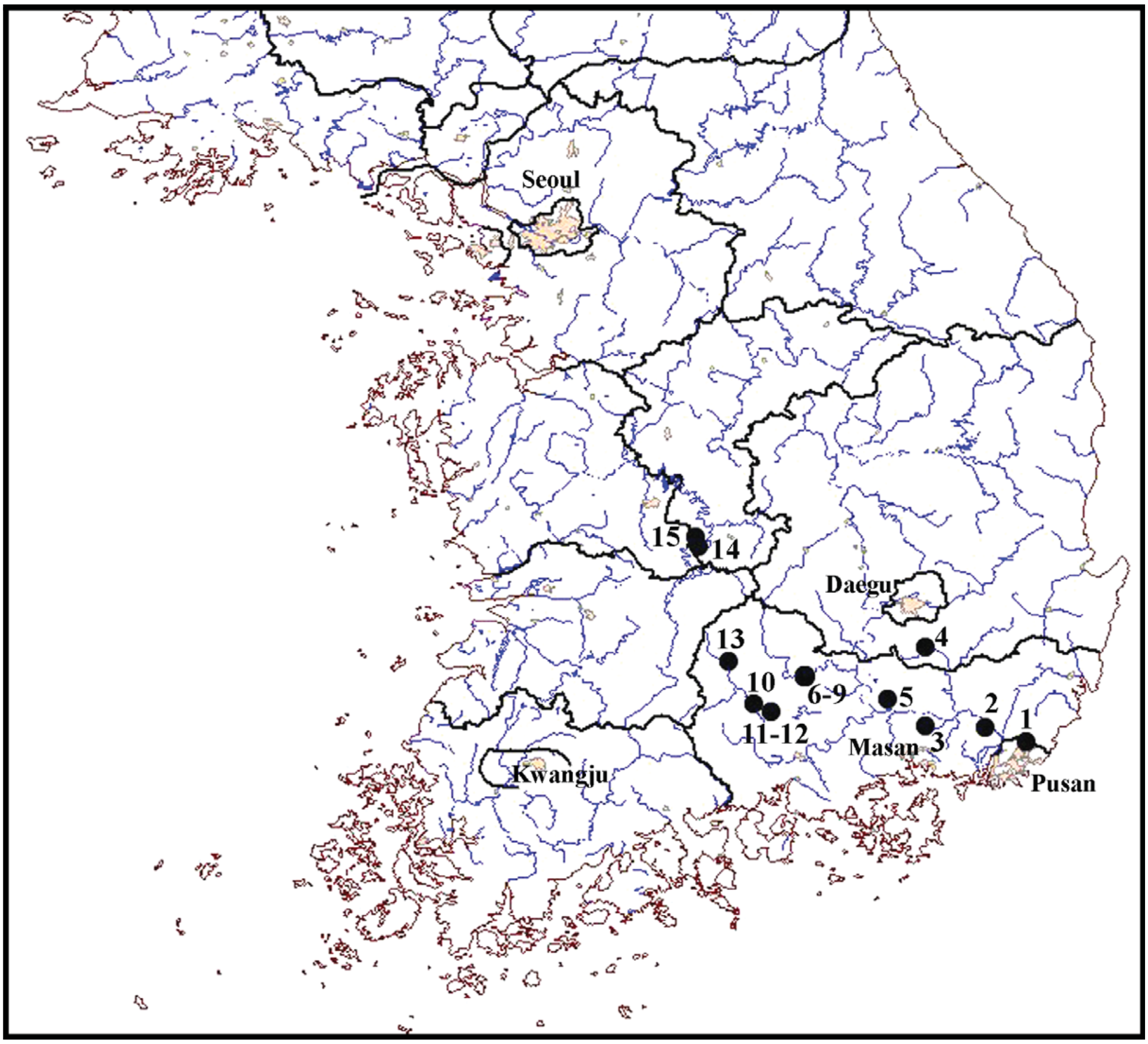

FIGURE. 1. Region of study. Numbers represent localities listed in Table 1.

specimens were selected from samples under a binocular stereoscopic microscope, and studied under a compound optical microscope in a drop of a glycerol-formaldehyde mixture. Few females of each species (if possible) were dissected under a stereoscopic microscope for the study of appendages and postabdomen. Drawings were prepared using a camera lucida attached to a Zeiss Axioscop II compound microscope.

TABLE 1. Studied localities. Numbers in the first column correspond to those in Fig. 1.

No	Locality name	Water body type	N, degree with decimals	E, degree with decimals	Date of sampling	t, ºC	pH	Water Conductivity, µScm	Oxygen, mg/l
1	Hoe Dong	Large artificial lake with a multipurpose dam, catchment area 101.2 km^2	35.2445	129.12443	23.08.2010	30.64	10.35	176	15.99
2	Yong Mae Andl, near Pusan	Stream connected with Nakdong River	35.3109	128.9351	14.09.2011				
3	Ju Namji	Reservoir for agricultural water	35.3131	128.6686	10.04.2010	17.1	7.7	360	9.3
4	Yong Yeon Ji	Reservoir for agricultural water, catchment area 68.9 km^2	35.6683	128.6648	14.04.2010	10.14	8.9	238	11.57
5	Jang Cheokji	Reservoir for agricultural water;catchment area 6.3 km^2	35.4358	128.4945	10.04.2010	16.9	7.80	135	9.82
6a	Bak Sil Ji 1	Large lake in wetland	35.5441	128.1187	16.05.2010	22.8	8.5	224	9.31
6b					15.09.2011	24.7	7.83	125	6.8
7a	Bak Sil Ji 2 (=Hae Gok Kyo)	Oxbow lake	35.5347	128.1191	16.05.2010				
7b					15.09.2011	28.8	7.94	122	7.8
8	Bak Sil Ji 3	Large lake in wetland	35.5385	128.1262	15.09.2011	29.5	7.71	126	2.77
9	Bak Sil Ji 4	Large lake in wetland	35.54094	128.1239	15.09.2011	22.4	6.54	103	0.71
10	Sal Go Gae Ji	Shallow artificial pond	35.4128	127.8921	16.09.2011	27.3	8.36	114	9.02
11	Seon You Dong	Small natural pond	35.3819	127.9719	16.09.2011	24.7	7.66	14	6.8
12	Cheok Ji Ri	Shallow artificial pond	35.4029	127.9505	16.09.2011	28.2	8.84	26	9.73
13	Si Mock Ri	Rice field	35.6069	127.7759	16.09.2011	23.4	7.85	43	7.1
14	Ho Tan	Back marsh connected with Geom river	36.1274	127.6418	17.09.2011	24.1	7.89	34	1.01
15	Nu Gyo Ri	Large man-made reservoir	36.1679	127.6262	17.09.2011	25.6	7.98	23	7.74

Results

Order Ctenopoda Sars, 1865

Family Sididae Baird, 1850

1. *Sida ortiva* Korovchinsky, 1979

Fig. 2

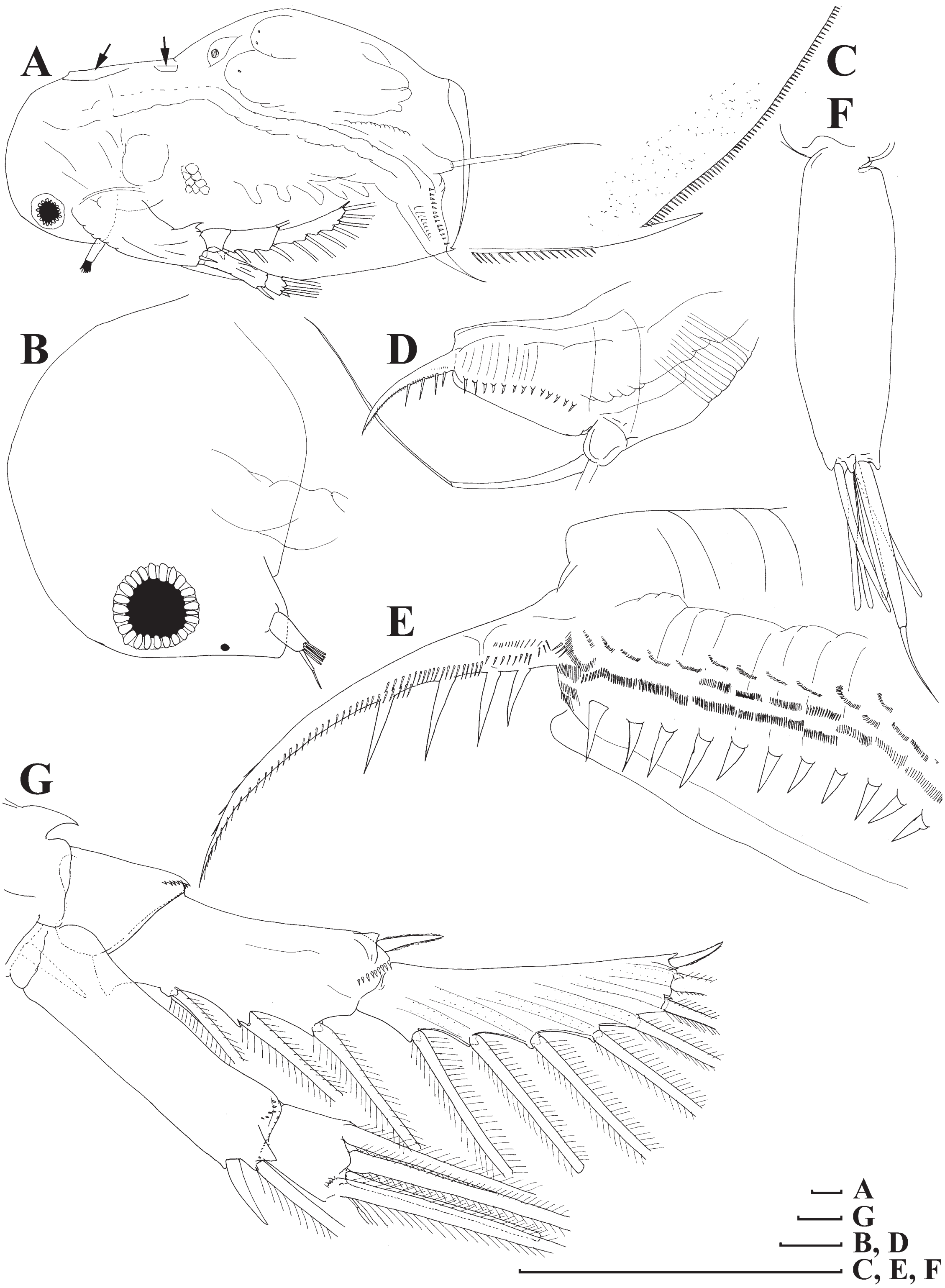

FIGURE 2. *Sida ortiva* Korovchinsky, 1979, parthenogenetic female from Seon You Dong, locality 11: A, lateral view; B, head; C, postero-ventral portion of valves; D, postabdomen; E, its distal portion; F, antenna I; G, antenna II. Scale bars: 0.1 mm.

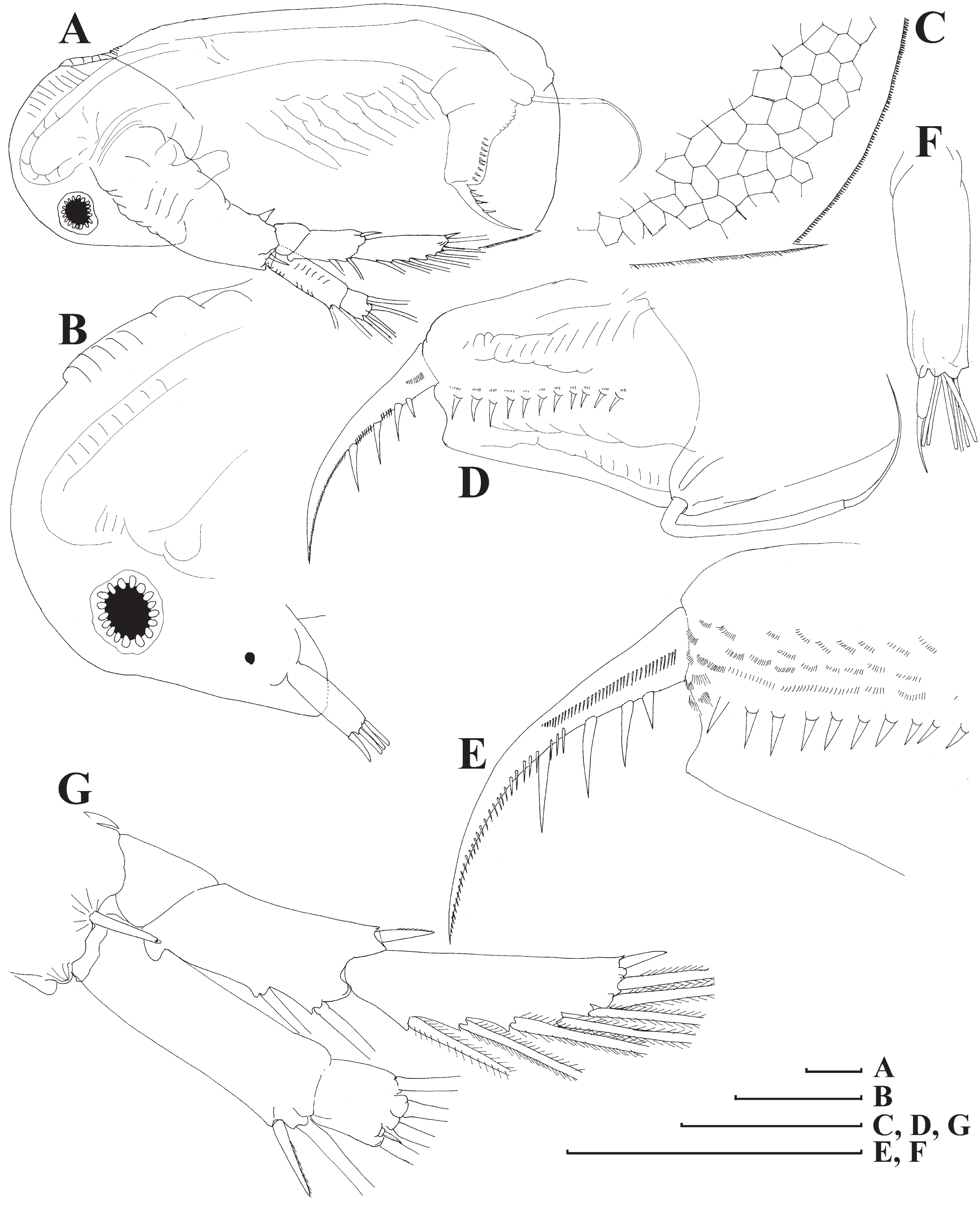

FIGURE 3. *Sida crystallina* (O.F. Müller, 1776), parthenogenetic female from Cheok Ji Ri, locality 12: A, lateral view; B, head; C, postero-ventral portion of valves; D, postabdomen; E, its distal portion; F, antenna I; G, antenna II. Scale bars: 0.1 mm.

Synonymy. *Sida crystallina ortiva* Korovchinsky, 1979, p. 1785–1786, Fig. 2: 1–2, 7, 9, 12; Korovchinsky 2004, p. 253, Fig. 79: 4, 6, Fig. 80: 2, 5; Kotov et al. 2011b, p. 404.

Type locality. "The Amur River near mouth of the Sungari River", Jewish Autonomous Area, Russia (Korovchinsky 1979). Coordinates: approximately 47.7ºN, 132.5ºE.

Localities in Korea. 1, 10, 11 (see Fig. 1 and Table 1).

Parthenogenetic female. Body ovoid, head small, with a large anterior and a pair of smaller anchor organs (Fig. 2A, arrows) dorsally, dorsal margin convex, postero-dorsal angle expressed, posterion margin straight, postero-ventral margin expressed, bearing a spine. Rostrum relatively short, directed ventrally, compound eye large, situated near ventral head margin, ocellus very small (Fig. 2B). Posterior valve margin with a row of numerous marginal spinules (Fig. 2C). Postabdomen trapezium-shaped, comparatively short; ventral margin straight, preanal margin long, straight, anus opens distally (Fig. 2D–E). Row of 12–14 anal teeth along each lateral side, rows of minute spinules near these teeth. Postabdominal claw regularly bent, with four basal spines, proximal most spine only somewhat smaller than next spine (Fig. 2E). Postabdominal setae long, about 0.4 of body length, located on a strong projection. Antenna I long, with distal aesthetascs and distal sensory seta longer than the former (Fig. 2F). Antenna II long, basal segment long, with some spines distally (Fig. 2G). Antennal formula in our material: setae 0 −4-7/ 0−1−4. Six pairs of thoracic limbs, not different from those in *S. crystallina* described by Korovchinsky (2004). Size in our material 1.5–2.4 mm.

Notes. *Sida crystallina ortiva* Korovchinsky, 1979 was established at the subspecies rank. But preliminary molecular phylogenetic studies suggest deep divergence with *S. crystallina* (O.F. Müller, 1776) (Kotov & Taylor, unpublished). *Sida crystallina* is widely distributed in the Western Palaeractic and penetrates Eastern Palaearctic up to Far East; *S. ortiva* is present in Siberia, Far East of Russia and more southern areas of eastern and south-east Asia (Korovchinsky 2004; Kotov et al. 2011b). Both species are found in South Korea. *S. crystallina* was found by us in localities 3 and 12, see Fig. 3A–G, and was illustrated by Kim & Yoon 1987, Fig. 2a–e and Yoon 2010, Fig. 18B. It differs from *S. ortiva* mainly in (1) longer rostrum projected posteriorly; (2) proximal most basal spine on postabdominal claw significantly shorter than the next spine and located close to it.

2. *Pseudosida cf. szalayi* (Daday, 1898)

Fig. 4

Synonymy. *Parasida szalayi* Daday, 1898, p. 64–66, Fig. 33a–d.
Pseudosida szalayi (Daday) in Korovchinsky 1992, p. 67, 70, Figs 330–335; Korovchinsky 2004, p. 339, Fig. 134, Fig. 135: 2–7; Korovchinsky 2010, p. 3–14, Figs 1–8.
Pseudosida bidentata Herrick in Ching & Du 1979, p. 99–100, Fig. 67.
See further synonymy in Korovchinsky (2010).

Type locality. "Swamp near Lake Kalawewa", Sri Lanka (according to lectotype, see Korovchinsky 2010).

Locality in Korea. 8 (see Fig. 1 and Table 1).

Parthenogenetic female. Body ovoid, elongated, head small, dorsal margin convex, postero-dorsal angle expressed, posterior margin convex, postero-ventral margin strongly projected (Fig. 4A). Rostrum directed ventrally, compound eye large, situated near antero-ventral head margin, ocellus small (Fig. 4B). Setae at antero-ventral portion of valve relatively short, not specially elongated and modified (Fig. 4C). Posterior valve margin with an inner row of numerous submarginal spinules and clusters of smaller spinules. Postabdomen subrectangular, comparatively short; ventral margin straight, preanal margin long, concave with a projection near anus, "terminal outgrowth" in terminology of Korovchinsky (2011) (Fig. 4D). Row of 10−12 clusters of anal teeth along each lateral side, mostly with 3−6 teeth in each cluster; rows of minute spinules near clusters of anal teeth. Groups of comparatively large spines laterally to postabdominal claw base (Fig. 4E). Postabdominal claw regularly bent, with three basal spines, two of which are long and proximalmost one very small. In a single female there were two very small spinules in position of proximal basal spine (Fig. 4D), numerous large spinules distally on ventral side of the claws (Fig. 4E). Postabdominal setae long, about 0.54 of body length. Antenna I long (Fig. 4A–B), with aesthetascs on a small lateral prominence in its middle; distally a large sensory seta armed with long setules (Fig. 4F). Antenna II long, basal segment long, with a spine in its distal portion between branches and a denticle laterally (Fig. 4G). Exopod bisegmented, proximal segment distally with a large spine and a large denticle; distal segment with a small prominence proximally and a large spine with small hillock near it distally (Fig. 4H). Endopod three-segmented, second segment long and stout, apically with a long seta and a short spine, apical segment with three setae and a spine. Antennal formula in our material: setae (5−7) − (10−11) / 0−1−3. Six pairs of thoracic limbs, as described by Korovchinsky (2010). Size in our material 1.22–1.75 mm.

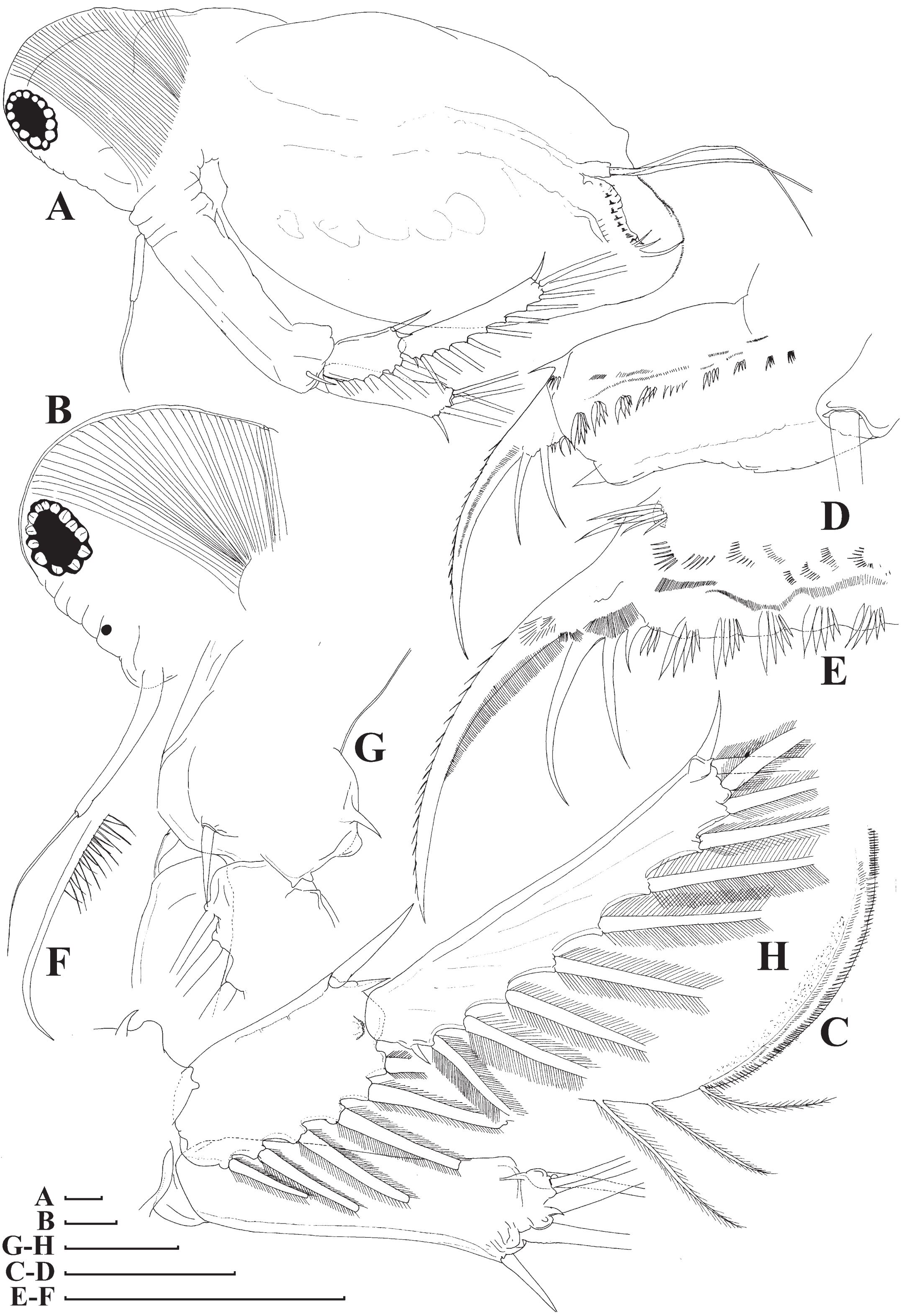

FIGURE 4. *Pseudosida cf. szalayi* (Daday, 1898), parthenogenetic female from Bak Sil Ji 3, locality 8. A, lateral view; B, head; C, postero-ventral portion of valve, inner view; D, postabdomen; E, its distal portion; F, distal sensory seta of antenna I; G, distal portion of basal segment of antenna II; H, branches of antenna II. Scale bars: 0.1 mm.

Notes. Korovchinsky (2010) pointed out that previous Asian records of *P. bidentata* Herrick, 1884 are dubious, and these populations in reality belong to *P. szalayi*. The latter is found in Sri Lanka, India, Bangladesh, China and Amur basin in Far East of Russia (Korovchninsky 2010). So, its presence in Korea was quite expected. We provide the first record of the genus for Korea.

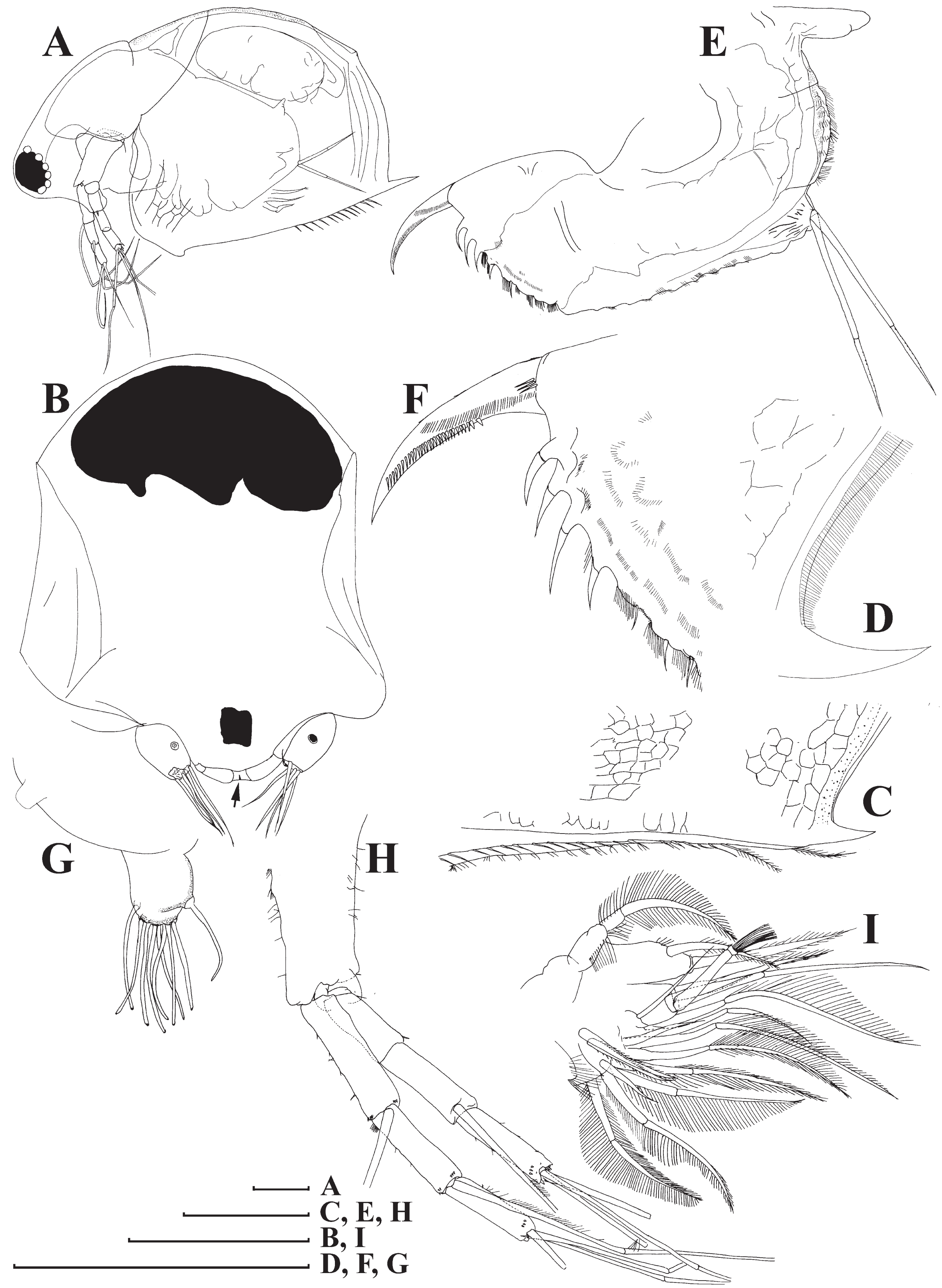

FIGURE 5. *Scapholeberis kingi* Sars, 1888, parthenogenetic female from Bak Sil Ji 1, locality 6a: A, lateral view; B, head, ventral view; C, postero-ventral valve portion, external view; D, posterior margin, inner view; E, postabdomen and abdomen; F, postabdominal claw; G, antenna I; H, antenna II, posterior view; I, limb I. Scale bars: 0.1 mm.

Order Anomopoda Sars, 1865
Family Daphniidae Straus, 1820

3. *Scapholeberis kingi* Sars, 1888
Fig. 5

Synonymy. *Scapholeberis kingi* Sars, 1888, p. 68; Chiang & Du, 1979, p. 145–146, Fig. 97; Dumont & Pensaert 1983, p. 24–25, Fig. 2: 3; Fig. 4: 4; Fig. VI: 1–2; Pl. 1: 8; Pl. 2: 4; Pl. 3: 5, 7, 9; Pl. 4: 1–7; Pl. 5: 1–2, 4; Fig. 10: 3; Pl. 6: 6–8; Fig. 12 Fig. 21: 4; Kotov *et al*. 2011a, p. 405.
Scapholeberis kingi n.sp. in Sars 1903, p. 8–10, Pl. 1: figs 2a–c.
Scapholeberis rammneri Dumont & Pensaert in Yoon 2010, p. 64–66, Fig. 34.

Type locality. "South Creek and Paramatta, New South Wales, Australia" (Dumont & Pensaert 1983).

Localities in Korea. 3, 5, 6a–b, 7a–b, 8, 9, 10, 13, 14 (see Fig. 1 and Table 1).

Parthenogenetic female. Brownish in colour. Body with dorsal margin interrupted by a cervical incision, postero-dorsal angle well-expressed, posterion margin slightly convex, postero-ventral angle with a strong spine - mucro, which is of 0.2 of valve length (Fig. 5A). Head rather large, lacking a horn, rostrum trilobate in ventral view (Fig. 5B), middle lobe with "a hyaline membrane in front" in terminology of Dumont & Pensaert (1983), compound eye very large, occupies distalmost portion of head (Fig. 5A). A ridge departs from the insertion of the second antenna and extends to the side of the head—seen frontally, it appear as a pair of shallow depressions, "auricles" in terminology of Dumont & Pensaert (1983). An elongate frontal head pore on the rostrum (Fig. 5B, arrow). Valves with reticulations as vertical lines near the posterior margin. A projection on ventral valve margin before the system of setae located on a flat portion, "sucker-plate" in terminology of Dumont & Pensaert (1983). A broad hyaline membrane extends beyond the posterior valve rim (Fig. 5–D). Postabdomen slightly widened distally, preanal margin long, preanal angle obtuse, anal margin straight, postanal angle not expressed, postanal margin very short (Fig. 5E). About 3–5 single postanal teeth, followed by clusters of spinules proximally (on anal margin), numerous series of minute setules laterally (Fig. 5F). In distal dorsal external pecten 2–4 proximalmost denticles specially strong and sparsely located. First antenna short, with antennular sensory seta and 9 terminal aesthetascs (Fig. 5G). Antenna II long, antennal formula: setae 0-1-3/1-1-3 (Fig. 5H). Limb I as shown in Fig. 5I. Other limbs not studied. Size in our material 0.5–1.0 mm.

Notes. According to Dumont & Pensaert (1983), this taxon is distributed in Australia, SE Asia, India, Middle East and Africa. It is known from the Far East of Russia (Kotov et al. 2011b), China (Chiang & Du 1979) and Japan (Mizuno & Takahashi 1991), so its presence in Korea was expected. Yoon (2010) described *S. mucronata* (O. F. Müller, 1776) and *S. rammneri* Dumont & Pensaert, 1983 from Korea, but we did not see these species in our samples. Probably this author misidentified *S. kingi* as *S. rammneri*. Unfortunately, descriptions and illustrations by Kim (1988), Kim & Yoon (1987) and Yoon (2010) do not allow us to assign their "*S. mucronata*" to any species, because most taxonomically important characters were not mentioned.

4. *Simocephalus congener* (Koch, 1841)
Fig. 6

Synonymy. *Daphnia congener* Koch, 1841, p. 35.13 (no figures); Orlova-Bienkowskaja 1998, p. 25–26, Fig. 34; Orlova-Bienkowskaja 2001, p. 78–80, Figs 51–57, 114–115, Pl. 6: fig. 30; Kotov et al. 2011a, p. 405.

Type locality. Not indicated in the original description. Probably in Germany (Orlova-Bienkowskaja 1998).

Locality in Korea. 6a (see Fig. 1 and Table 1).

Parthenogenetic female. Body subovoid, dorsal margin with a shallow cervical incision, postero-dorsal angle broadly rounded, without any projection and prominence anterior to it, posterior margin almost straight, fluently turned to ventral margin without any angle, ventral margin convex (Fig. 6A). Head with a small rostrum; large compound eye occupies antero-ventral portion of head; ocellus small, of irregular shape (Fig. 6B). Labrum fleshy, with a large, setulated distal labral plate. Valve with a row of numerous setae submarginally near ventral margin; in its posterior portion it turns to a row of grouped setules, with size increasing dorsally in each series (Fig. 6C). Postabdomen with an undulated preanal margin, strongly prominent preanal angle, convex anal margin,

undistinguishable postanal angle and a very small postanal margin (Fig. 6D). Few strong, single postanal teeth, bearing minute setules (Fig. 6E). Postabdominal claw long, slightly curved, with about 15 small, thin teeth in first (proximal) pecten, more than 20 relatively thin teeth in second pecten, and numerous fine setules in third pecten (Fig. 6E). Antenna I short, with a strong antennular sensory seta on a special projection and nine terminal aesthetascs (Fig. 6B, F). Antenna II long, antennal formula: setae 0-0-1-3/1-1-3, a small spine on proximal segment of exopod (Fig. 6G). Limb I as illustrated in Fig. 6H. Other limbs described by Orlova-Bienkowskaja (1998). Size in our material 1.5–1.9 mm.

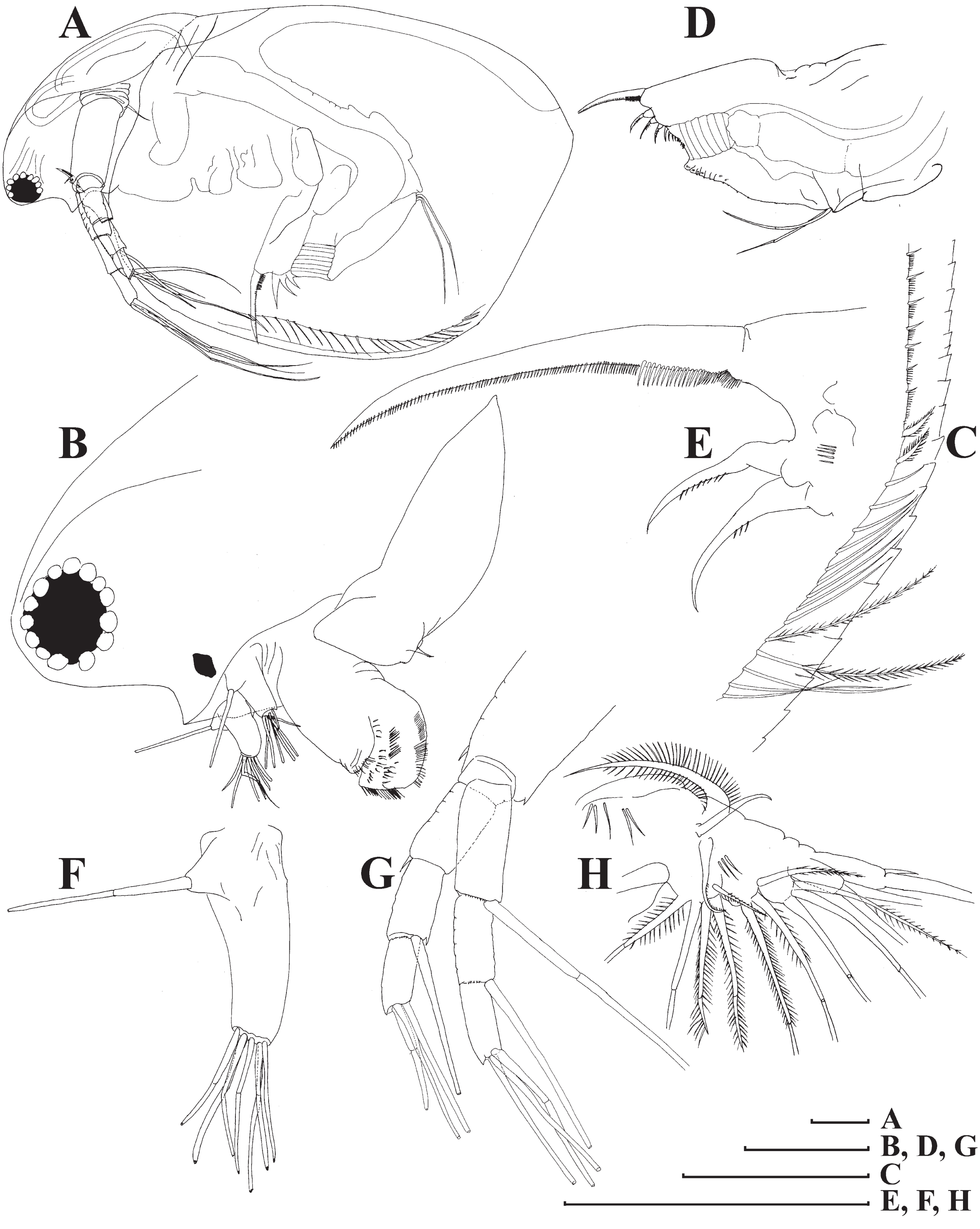

FIGURE 6. *Simocephalus congener* (Koch, 1841), parthenogenetic female from Bak Sil Ji 1, locality 6a: A, lateral view; B, head; C, postero-ventral portion of valve, inner view; D, postabdomen; E, its distal portion; F, antenna I; G, antenna II; H, limb I. Scale bars: 0.1 mm.

Notes. Orlova-Bienkowskaja (2001) stated that "This species was previously confused with *S. exspinosus,* so its range needs to be redefined. It occurs with certainty in Central and Eastern Europe and Siberia". Recently this taxon was also found in the Far East of Russia (Kotov et al. 2011b). Most probably, *S. exspinosus* (Koch, 1841) illustrated by Kim & Yoon (1987) and Yoon (2010) could also be *S. congener*, but the distal portion of the postabdominal claw was illustrated inadequately. At this moment, this taxon could be regarded as Palaearctic, penetrating to the South.

Family Moinidae Goulden, 1968

5. ***Moinodaphnia macleayi*** **(King, 1853)**
Fig. 7

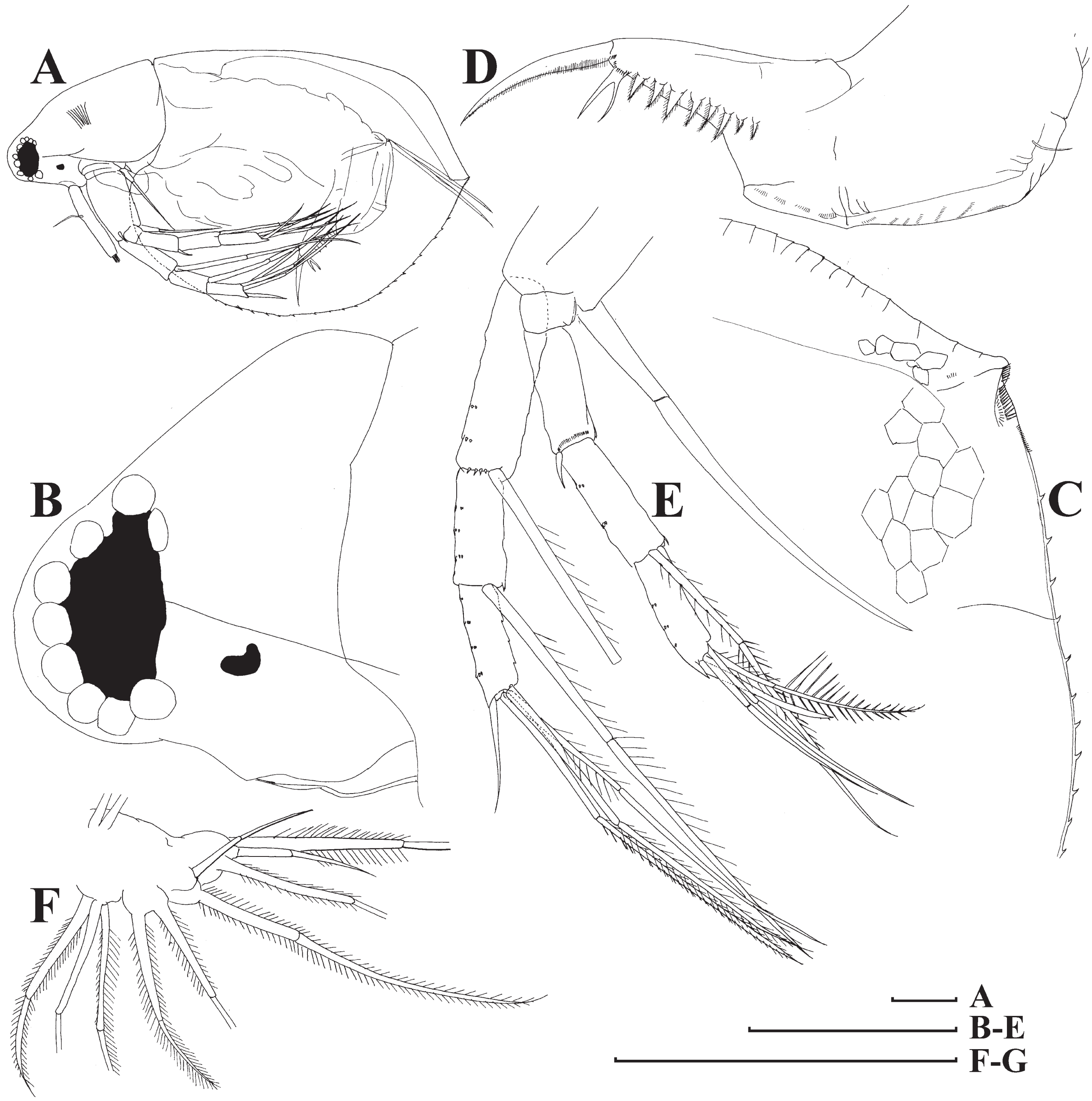

FIGURE 7. *Moinodaphnia macleayi* (King, 1853), parthenogenetic female from Bak Sil Ji 1, locality 6a: A, lateral view; B, head; C, postero-dorsal portion; D, postabdomen; E, antenna II; F, limb I. Scale bars: 0.1 mm.

Synonymy. *Moina macleayi* King, 1853, p. 251–252, Pl. 5.
Moinodaphnia macleayi (King) in Goulden 1968, p. 84–87, Figs 45–46; Smirnov 1976, p. 187–189, Figs 165–166; Chiang & Du 1979, p. 161–162, Fig. 108.
Moina submucronata Brady, 1886, p. 294, Pl. 37: figs 4–5.

Type locality. "Pond near Elizabeth Bay, Sydney" (King 1853), New South Wales, Australia.

Locality in Korea. 6a (see Fig. 1 and Table 1).

Parthenogenetic female. Body subovoid, dorsal margin with a wear cervical incision, postero-dorsal angle as a rounded triangle (Fig. 7A–B), posterior margin fluently turned to ventral margin without any angle, ventral margin convex; no hairs anywhere else on the head or valves. Body compressed laterally, with a well-expressed median keel on dorsal portion of valves. Head small, sub-triangular, with a shallow supra-ocular depression above large compound eye which fills the tip of the head; ocellus small (Fig. 7B). Valves reticulated, ventral margin with denticles, a pair of submarginal hooks at the point where the valves come together (Fig. 7C). Postabdomen with wide preanal and narrow postanal portions, preanal margin large and lacking long setules, preanal angle distinct, anal margin straight, postanal angle expressed, postanal margin straight (Fig. 7D). On postanal portion, eight-nine feathered lateral teeth plus a long, bident tooth near base of postabdominal claw. Postabdominal claw long, with two pectens of thin setules. Antenna I long, cylindrical, antennular sensory seta originated somewhat proximally to its middle; nine very short aesthetascs distally (Fig. 7A). Antenna II thin and long, basal segment with a long seta on posterior side (Fig. 7E). Antennal formula: setae 0-0-1-3/1-1-3, spines 0-1-0-1/0-0-1. Apical spine on exopod specially long, so, it is sometimes counted as a seta (Smirnov, 1976), but we think that antennal formula as suggested here is more correct for homologization of setae and spines on antenna II on *Moinodaphnia* and other anomopods. Limb I as illustrated in Fig. 7F. Size in our material 0.7–1.2 mm.

Notes. According to Smirnov (1976), *Moinodaphnia macleayi* is a circumtropical species. Most probably Korea is the northernmost area of its distribution. The species is also known from China (Chiang & Du 1979) and Japan (Mizuno & Takahashi 1991). This is the first record for Korea.

Family Ilyocryptidae Smirnov, 1976 sensu Smirnov, 1992

6. *Ilyocryptus cuneatus* Štifter, 1988

Figs 8–9

Synonymy. *Ilyocryptus cuneatus* Štifter, 1988, p. 292–296, Figs 7–19; Tanaka 2001, p. 221, Fig. 3A–E; Kotov & Štifter 2006, p. 76–81, Figs 2G, 35–38; Kotov et al. 2011a, p. 405.

Type locality. "West Bohemia, Březová reservoir on the river Teplá, 5 km south of Karlovy Vary" (Štifter 1988), Czech Republic.

Localities in Korea. 6a, 7b, 8, 14 (see Fig. 1 and Table 1).

Parthenogenetic female. Body triangular-ovoid, postero-dorsal angle expressed (Fig. 8A). In anterior view, body thick, with thick and low dorsal keel, without lateral horns. Moulting incomplete. Ocellus small (Fig. 8B). Head shield with mandibular articulation as a small projection (Fig. 8C). Setae at ventral margin plumose (Fig. 8D). Each seta at posterior margin with a long, stout basal part, than with a series of 2–4 stout spine-like setules along one side in its basal portion, and with fine hairs in distal portion (Fig. 8E). Anus opens in the middle between base and distal extremity of postabdomen; preanal teeth 10–12, subequal in size, both doubled and single in the same specimen, few denticles on postabdomen base laterally (Fig. 8F). Paired spines shorter than large lateral setae. Postabdominal claw with a single denticle in distal part, no denticles in its middle part, distal and proximal spines on claw base subequal in size; setules situated on base of claw ventrally long (Fig. 8G). Antenna I relatively long, with transverse ridges (Fig. 8B). Proximal segment with a finger-like projection and few low hillocks (Fig. 8H). The longest aesthetasc about half the distal segment. Antenna II short, distal burrowing spine relatively short, with tip almost reaching or reaching distal border of basal segment (Fig. 9A). Both antennal branches short (Fig. 9B–C). Apical swimming setae relatively short, armed with short setules distally (Fig. 9D). Proximal lateral swimming seta shorter than distal one, both without hooks on tips and armed along one side with setules analogous to these of apical setae, and more stout and long setules along other side (Fig. 9E–F). Spine on second segment of exopod equal to or somewhat shorter than half of third segment (Fig. 9B–C). A large seta near ejector hooks of

limb I. Gnathobase I as a setulated hillock. Limb VI with row of long setules along inner margin subdivided into six bundles by small incisions on the margin. Size in our material 0.61–0.83 mm.

Notes. The species is widely distributed in the Northern Palaearctic and Nearctic (Kotov & Štifter 2006) and found close to Korea: Japan (Tanaka 2001) and the Amur basin in Far East of Russia, where it is quite common (Kotov et al. 2011a). We found it also to be common in the Korean Peninsula, which could be the southernmost area of its distribution in Asia. Unfortunately, there is no information on its presence in China, and previous descriptions of ilyocryptids (Chiang & Du 1979) are not detailed enough to separate *sordidus*-like species sensu Kotov & Elías-Gutiérrez (2009). Korean specimens are somewhat different from European ones in: (1) only few denticles on postabdomen base laterally; (2) ridges, although ill-expressed, on distal segment of antenna I. It is possible that populations from the Far East form a separate taxon, but this idea could be confirmed only in the course of a global revision of the *cuneatus*-like populations in the Palaearctic.

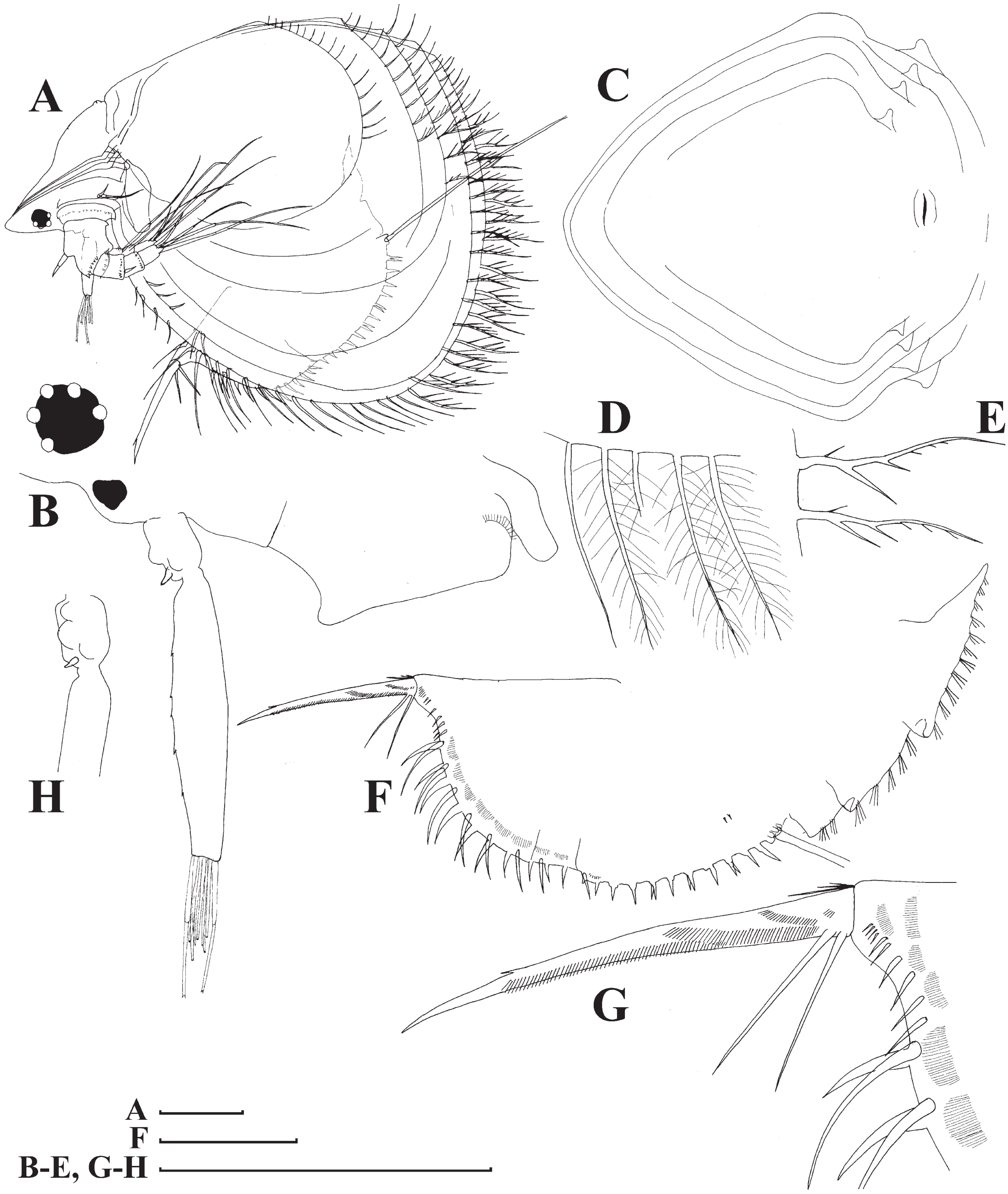

FIGURE 8. *Ilyocryptus cuneatus* Štifter, 1988, parthenogenetic female from Bak Sil Ji 1, locality 6a: A, lateral view; B, head, lateral view; C, head shield; D, setae at middle of ventral margin; E, setae at posterior valve margin; F, postabdomen; G, its distal portion and postabdominal claw; H, proximal portion of antenna I . Scale bars: 0.1 mm.

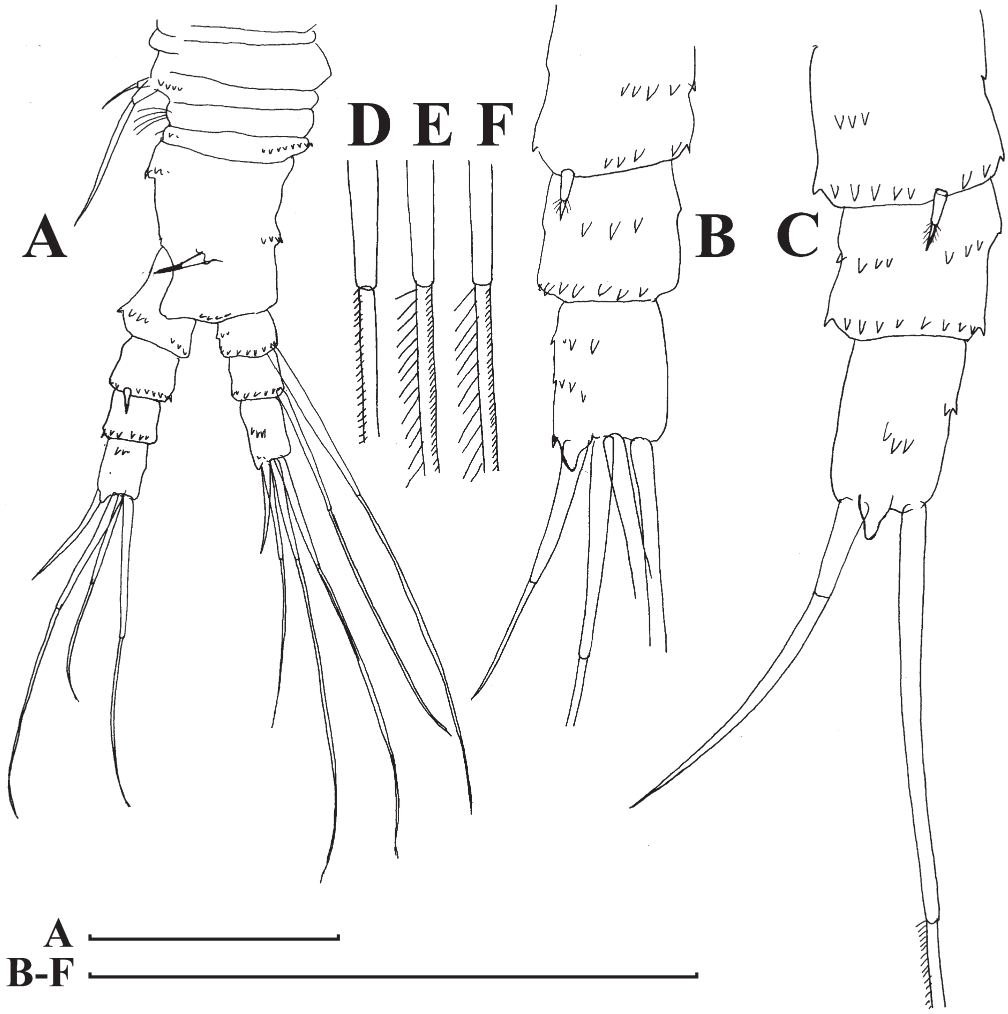

FIGURE 9. *Ilyocryptus cuneatus* Štifter, 1988, antenna II of parthenogenetic female from Bak Sil Ji 1, locality 6a: A, anterior view; B–C, exopods of two different specimens; D, apical swimming seta; E–F, distal and proximal lateral swimming seta. Scale bars: 0.1 mm.

7. *Ilyocryptus cf. raridentatus* Smirnov, 1989

Synonymy. *Ilyocryptus raridentatus* Smirnov, 1989, p. 58, Pl. 4: figs 1–6.
Ilyocryptus cf. sarsi from Far East of Russia in Kotov & Štifter 2006, p. 123.
Ilyocryptus cf. raridentatus Smirnov in Kotov et al. 2011b, p. 135–136, Fig. 33.

Type locality. "An unnamed swamp near Yarragooly Claypan, via Derby, W.A." (Smirnov 1989), Australia.

Locality in Korea. 6a (see Fig. 1 and Table 1).

Notes. Two females from Bak Sil Ji were identical to those earlier found in the Amur basin (see description in Kotov et al. 2011b) and preliminarily identified as *Ilyocryptus cf. raridentatus* Smirnov, 1989. The latter species was described from Australia (Smirnov 1989). It belongs to a circumtropical *I. sarsi*-group (Kotov & Štifter 2006) quite common in such Asian countries like Thailand and Malaysia. The Amur basin is the northernmost border of its distribution in Asia (Kotov et al. 2011b). Some populations from this group were previously found in Japan and few localities in Far East of Russia (Kotov & Štifter 2006), but their status could be checked only in the scope of a global revision of the *sarsi*-group. Presence of this taxon in Korea was quite expected after findings in adjacent territories, including more northern ones in Far East of Russia.

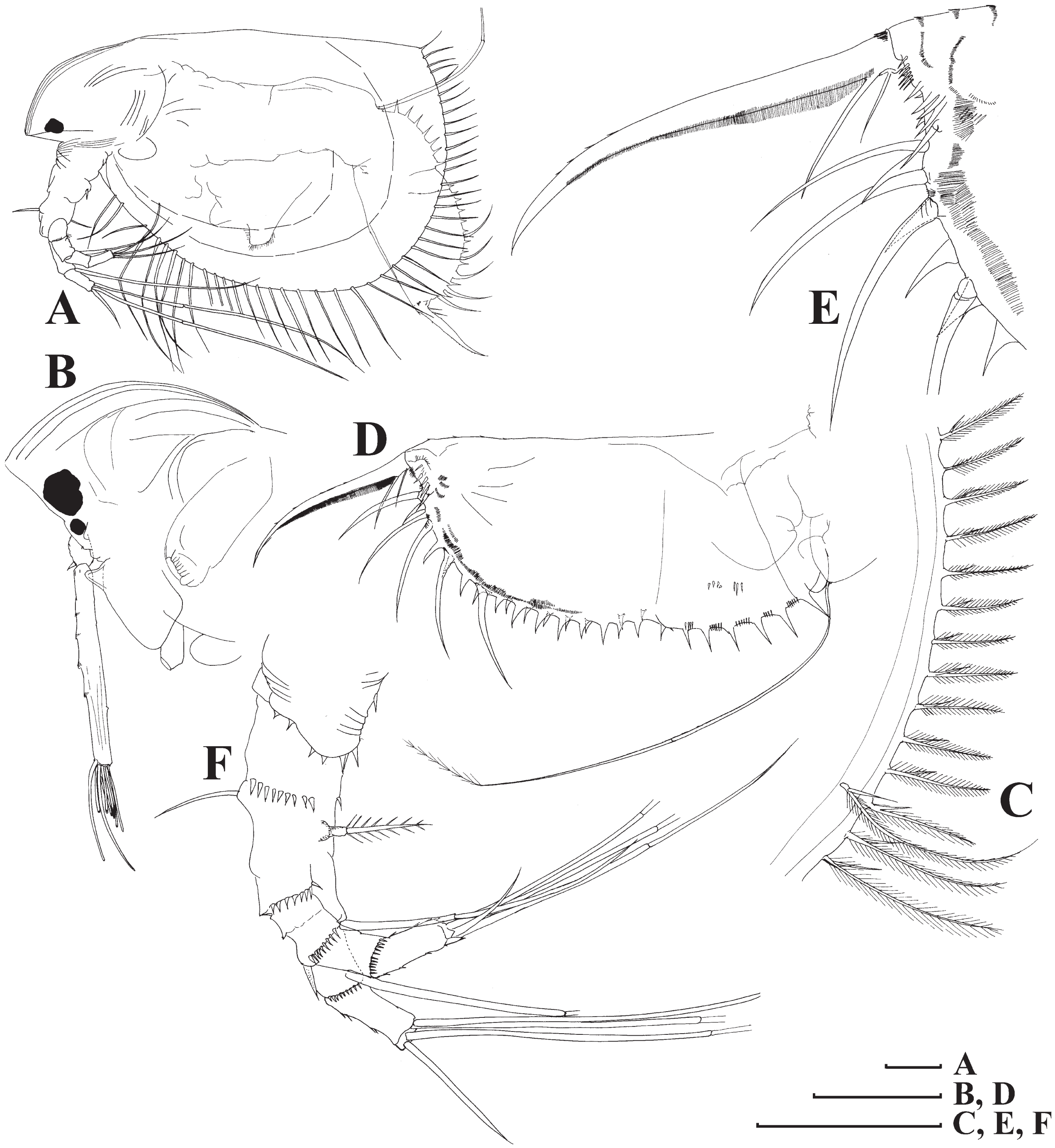

FIGURE 10. *Ilyocryptus spinifer* Herrick, 1882, parthenogenetic female from Bak Sil Ji 3. locality 8: A, lateral view; B, head; C, posterior valve margin; D, postabdomen; E, its distal portion; F, antenna II. Scale bars: 0.1 mm.

8. *Ilyocryptus spinifer* Herrick, 1882

Fig. 10

Synonymy. *Ilyocryptus spinifer* Herrick, 1882, p. 246, Pl. 8: Figs 2–6; Herrick 1885, p. 39–41, Pl. 9: Figs 1–3; Chiang & Du 1979, p. 182–183, Fig. 119; Kotov & Dumont 2000, p. 88–102, Figs 1–149; Tanaka 2001, p. 221–222, Figs 4A–E; Kotov & Štifter 2006, p. 139–144, Figs 1, 3, 6–7, 9–11, 69–70; Kotov et al. 2011b, p. 133–135, Fig. 2.

Ilyocryptus agilis Kurz in Kim 1988, Figs 45–46.

Ilyocryptus sordidus (Liévin) in Chiang & Du 1979, Fig. 117; Mizuno & Takahashi 1991, p. 159, text-fig.

Neotype locality. "A small bog located in an inlet stream of Lake Alice, Hubbard County, Minnesota, USA" (Kotov & Williams 2000). Coordinates are 47º13'30"N, 95º05'00"W.

Localities in Korea. 6a, 8, 14 (see Fig. 1 and Table 1).

Parthenogenetic female. Body triangular-ovoid, high, dorsum almost straight, postero-dorsal angle developed (Fig. 10A). Body compressed laterally, with well-developed dorsal keel, without lateral horns. Moulting incomplete. Head small, its ventral margin straight (Fig. 10B). Setae at postero-ventral valve portion also very long. Each seta of ventral margin plumose, each seta posterior edge with stout spine-like setule at base and long setules distally (Fig. 10C). Postabdomen elongated, anus opening more closely to base than to distal extremity of postabdomen (Fig. 10D). Preanal teeth 5–11, single, relatively large, increasing in size proximally, located at approximately right angle with margin, sometimes slightly bent. A group of setules near each of teeth. Numerous, relatively robust denticles on postabdomen base. Paired spines numerous, relatively small, reaching preanal margin. Lateral setae 5–7, long, a big gap between basalmost seta and anus. Postabdominal claws long, slightly bent and with tiny denticles in distal portion (Fig. 10E). Distal spine on claw base longer than proximal one. Setules ventrally on claw basal border short. Postabdominal setae shorter than body. Antennae I long and thin, proximal segment with big finger-like projection and system of hillocks (Fig. 10B). Distal segment with 5–6 transverse rows of denticles, but without denticles at distal end. Two aesthetascs longer than others and longer than half the distal segment, one of them at a short distance from the rest. Antenna II long. Distal sensory seta and distal burrowing spine long, projecting behind distal end of basal segment (Fig. 10F). Apical swimming setae long, with short setules. Both lateral setae asymmetrically feathered by short setules, with small hooks on tips. Apical spine on exopod approximately equal to spine on endopod. Length of spine on second segment of exopod shorter or equal to length of third segment. Limbs as described by Kotov & Dumont (2000). Size in our material 0.81–1.04 mm.

Notes. The species was initially described from Minnesota, U.S.A. (Herrick 1882a, b) and then found in many tropical and subtropical localities (Smirnov 1976; Kotov & Dumont 2000). It also penetrates the Nearctic up to 47ºN (Kotov & Williams 2000). The species was known from Japan (Tanaka 2001; Kotov & Štifter 2006). Recently it was found in the Amur basin (51ºN), which probably is the northernmost area of its distribution in the Far East (Kotov et al. 2011a, b). Korean specimens were morphologically undistinguishable from those found in the Amur basin (Kotov et al. 2011b). From illustrations of Kim (1988), it is obvious that he misidentified this taxon from Korea as *I. agilis*.

Family Macrothricidae Norman & Brady, 1867

9. *Macrothrix pennigera* Shen, Sung & Chen, 1961

Synonymy. *Macrothrix pennigera* Shen, Sung & Chen, 1961, p. 213–214, Figs 1–5; Chiang & Du 1979, p. 185–186, Fig. 121; Smirnov 1992, p. 100, Figs 426–430 (after Chiang & Du 1979).

Type locality. "A pond in the Cultural Palace, Peking" (Shen et al. 1961) China.

Locality in Korea. 6a (see Fig. 1 and Table 1).

Notes. This "haired" and "horned" taxon was described from Peking, China (Shen et al. 1961) and was not recorded again until now. It will be redescribed in a separate paper with discussion on its phylogenetic position.

10. *Macrothrix triserialis* Brady, 1886

Fig. 11–12

Synonymy. *Macrothrix triserialis* Brady, 1886, p. 295, Pl. 37: figs 16–20; Smirnov 1992, p. 51–55, Figs 191–205, 219, 225; Dumont et al. 2002, p. 6–7, Figs 18–20.
Not *M. triserialis* Brady in Chiang & Du 1979, Fig. 127.
See intensive synonymy in Smirnov (1992).

Type locality. "Colombo" (Brady 1886), Sri Lanka.

Locality in Korea. 6a (see Fig. 1 and Table 1).

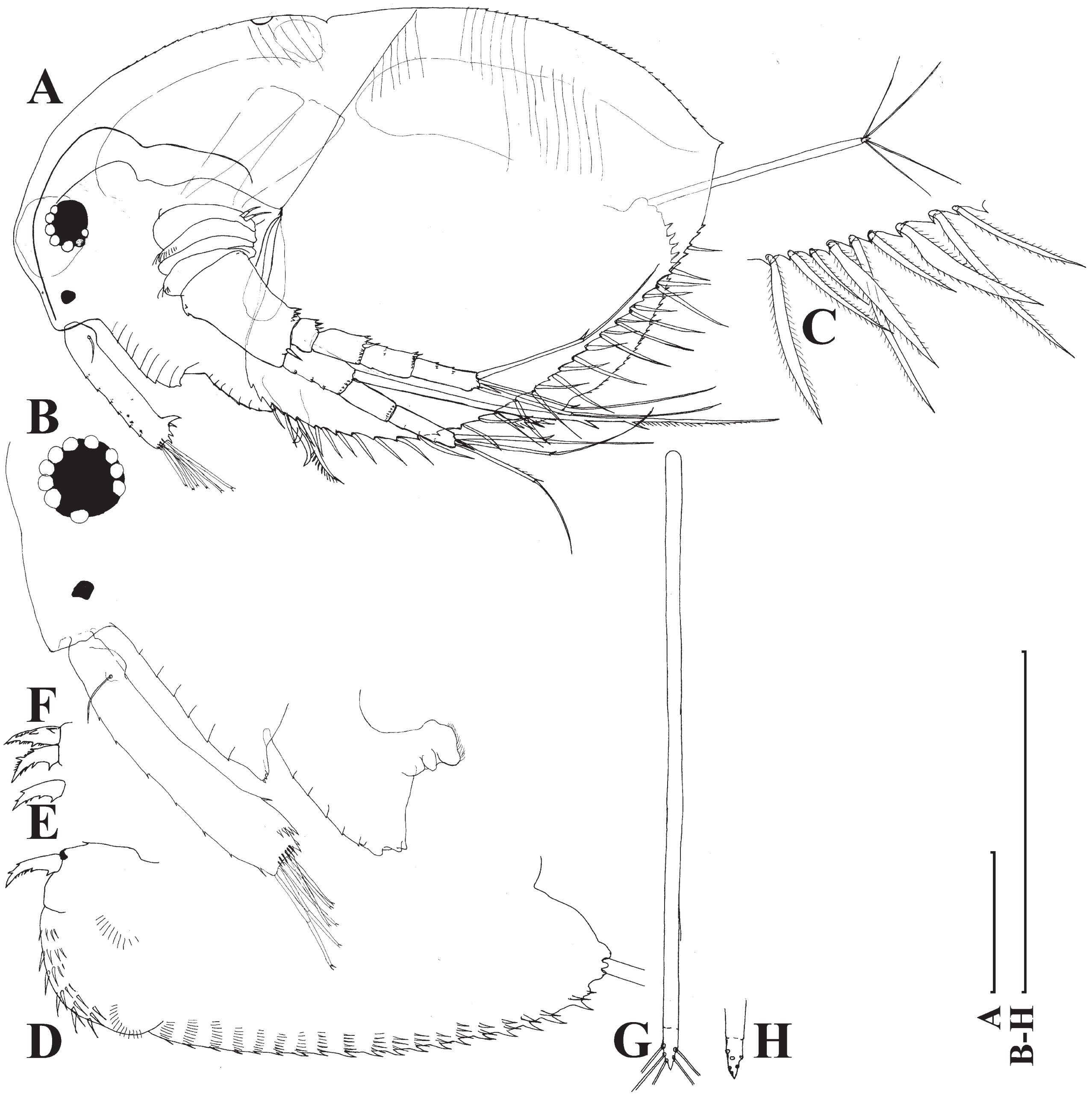

FIGURE 11. *Macrothrix triserialis* Brady, 1886, parthenogenetic female from Bak Sil Ji 1, locality 6a: A, lateral view; B, head, lateral view; C, setae at postero-vetral valve margin; D, postabdomen; E–F, postabdominal claws; G–H, postabdominal seta and its distal portion. Scale bars: 0.1 mm.

Parthenogenetic female. Body subovoid, dorsal margin in general regularly curved, with well-expressed ocular dome, shallow depression behind dorsal head pore, postero-dorsal as a pointed angle, lying somewhat above longitudinal body axis (Fig. 11A). Whole surface of head and valves covered with striae, with rare or numerous anastomousings. Body significantly compressed laterally, with sharp dorsal keel. Ventral head margin somewhat convex, with a projection anterior to labrum, which is sub-rectangular, with a series of tubercles at apex; ocellus small (Fig. 11B). Setae at ventral margin plumose, organized in short series of three setae of different size located at different angles, the first seta thick (Fig. 11C). Postabdomen subovoid, with rounded distal extremity, distinct heel basally, preanal margin with short transversal series of short to medium-sized setules; in basal portion these setules always longer and more robust (Fig. 11D). Postabdominal claw small, outer dorsal row of two large denticles: a 'basal spine' and second denticle, plus a small denticles distally; inner dorsal row with numerous

denticles, two of them remarkably more robust than the rest; ventral row of two denticles (Fig. 11D–F). Postabdominal seta with a very short distal segment, no setules on basal segment (Fig. 11G–H). Antenna I rod-like, sensory seta externally at a distance more than antennular diameter from antennule joint, about 7 transverse rows of denticles on anterior surface of antennule; nine short aesthetascs, two of them significantly larger than the rest (Fig. 11B, 12A). Antenna II with two small basal sensory setae of subequal size. Basal segment with distal burrowing spine equal in length to basal segment of exopod, naked; swimming setae 0-0-1-3/1-1-3, spines 0-1-0-1/0-0-1 (Fig. 12B). Largest seta (on basal endopod segment) with three strong spinules in middle portion, and a row of short setules in basal and distal portions (Fig. 12C). True spine on second segment of exopod with third length of this segment. Additional spines on exopod segments small, decreasing gradually in dorsal direction (Fig. 12B). On limb I, ODL with long apical seta, and small lateral seta; IDL with tree series of strong setules, and three bisegmented setae of different size, unilaterally setulated distally, two smaller two smaller ones hook-shaped (Fig. 12D). Other limbs as in females from type locality as described by Dumont et al. (2002). Size in our material 0.55–0.73 mm.

Notes. The *Macrothrix rosea-triserialis* group was revised during the last decade, and it was found that *M. triserialis* lives only in the tropics and subtropics of the Old World (Dumont et al. 2002; Kotov et al. 2004). Kim & Yoon (1987) and Yoon (2010) reported for Korea only a single species from this group, the palaearctic *M. rosea* (Jurine, 1820) (as *Echinisca*). We confirm its presence in Korea (see Figs 13–14 of *M. rosea* from Ho Tan wetland). *M. triserialis* differs from the latter in: (1) more expressed projection anterior to labrum; (2) thinner first seta in each triplet on valve; (3) very short distal segment of postabdominal seta; (4) three strong spinules in the middle of largest antennal seta. The finding of *M. triserialis* in Korea‘s non-subtropical climate (i.e. winters with negative temperatures) was quite surprising. Taking into consideration that "*M. triserialis*" in Fig. 192 by Chiang & Du 1979 is apparently *M. rosea*, the presence of *M. triserialis* in China needs to be confirmed. The latter we now consider as a tropicopolitan species (=species widely distributed in the tropics, but capable of penetrating more northern territories).

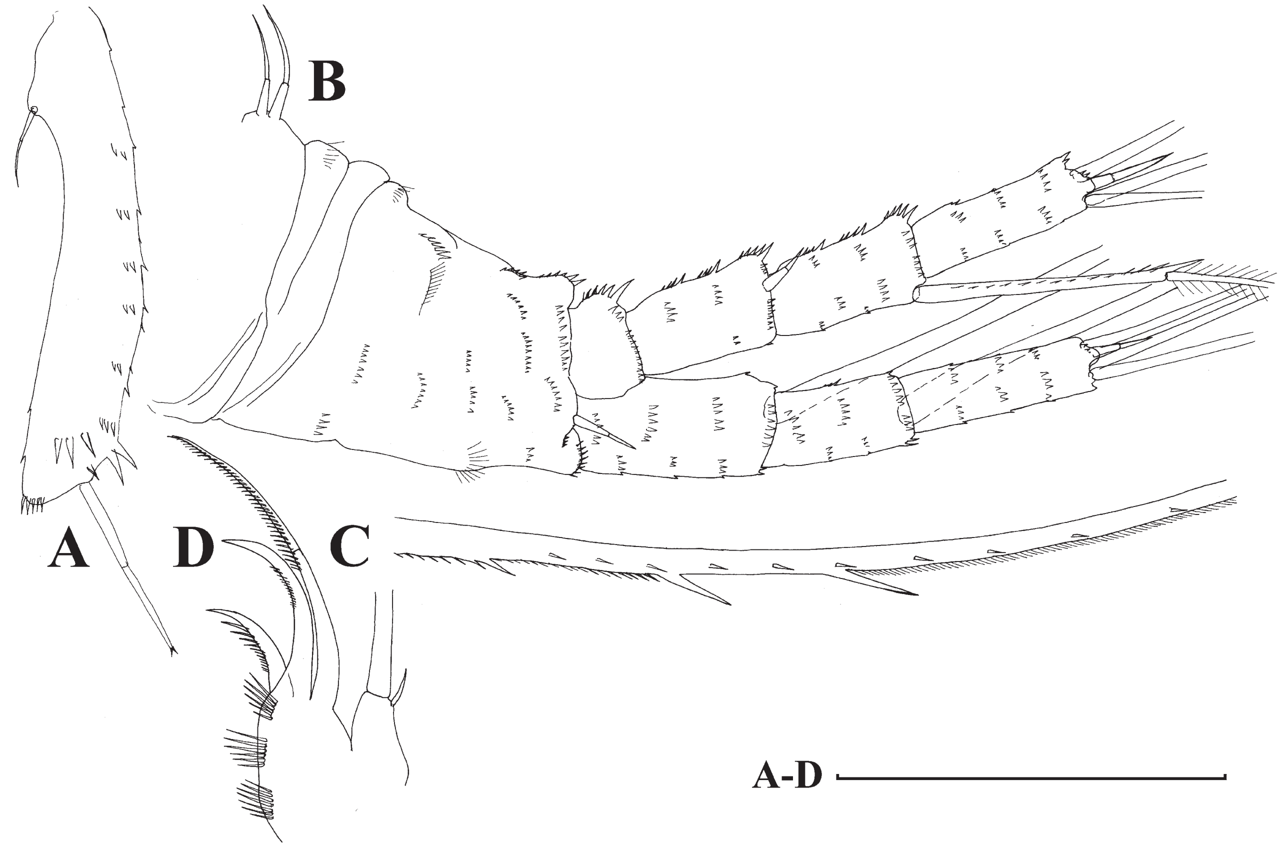

FIGURE 12. *Macrothrix triserialis* Brady, 1886, appendages of parthenogenetic female from Bak Sil Ji 1, locality 6a: A, antenna I; B, antenna II, anterior view; C, setae of endopod proximal segment; D, distal portion of limb I. Scale bars: 0.1 mm.

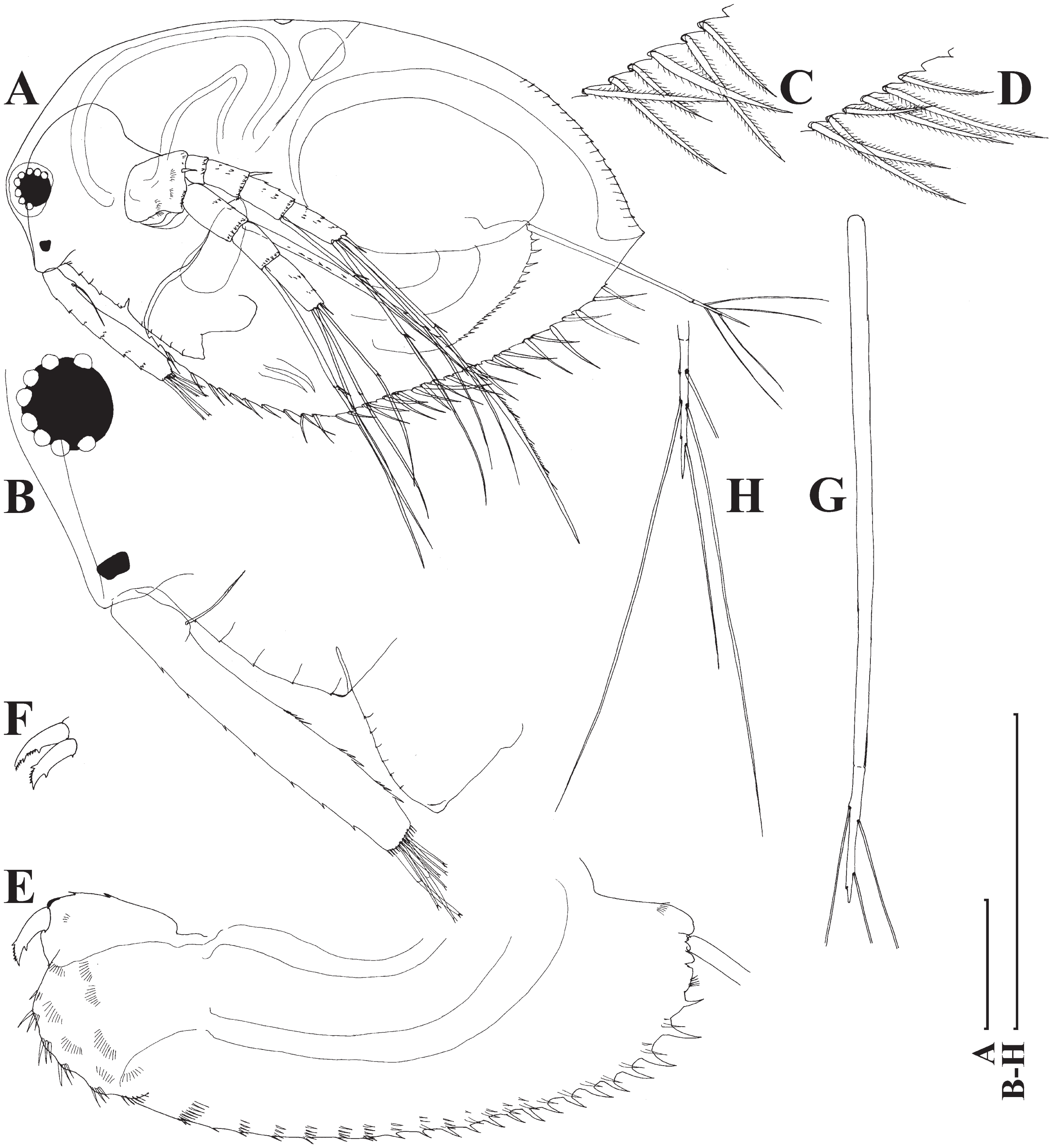

FIGURE 13. *Macrothrix rosea* (Jurine, 1820), parthenogenetic female from Ho Tan wetland: A, lateral view; B, head, lateral view; C–D, setae at postero-vetral valve margin; E, postabdomen; F, postabdominal claw; G–H, postabdominal seta and its distal portion. Scale bars: 0.1 mm.

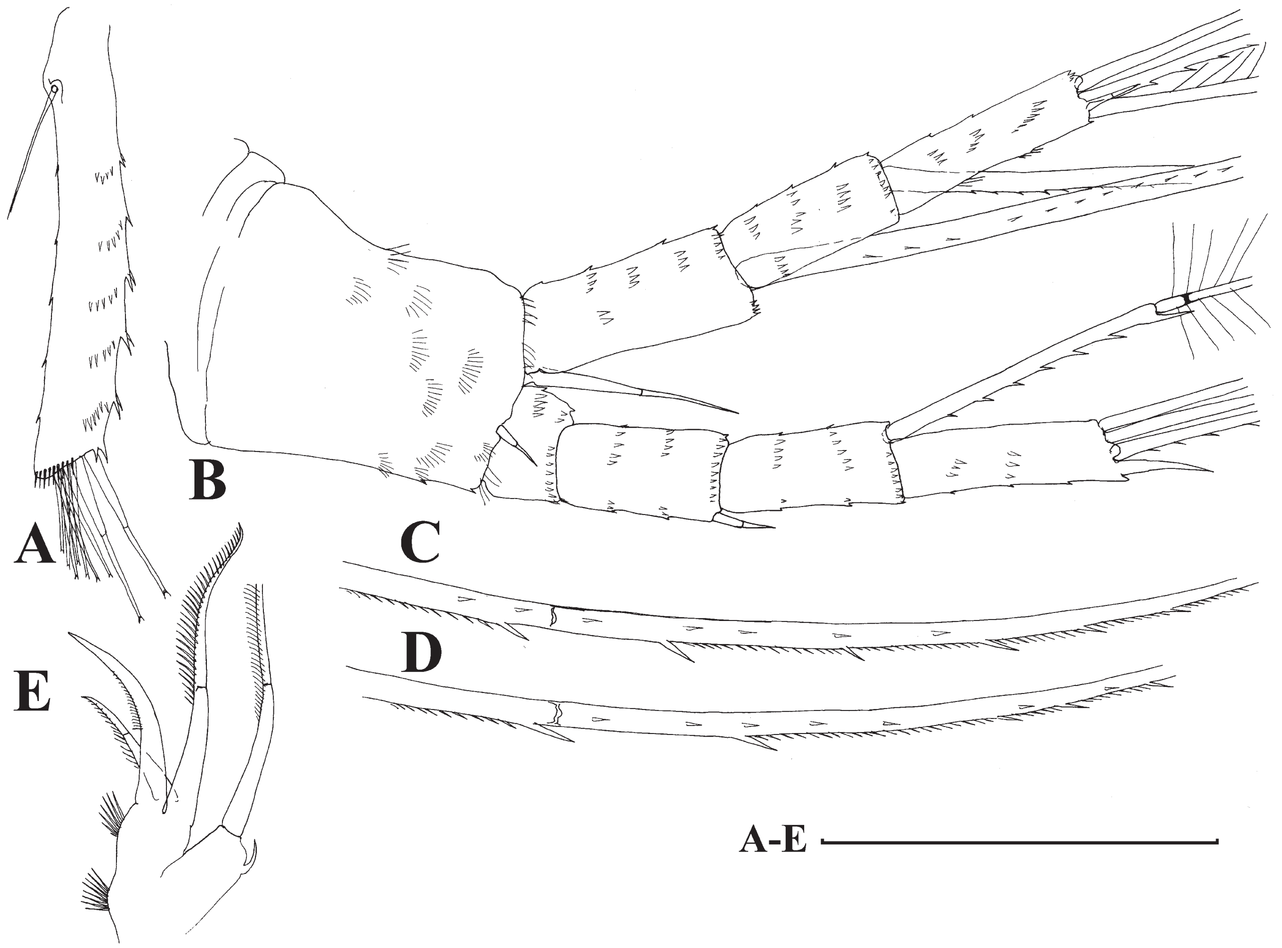

FIGURE 14. *Macrothrix rosea* (Jurine, 1820), appendages of parthenogenetic female from Ho Tan wetland: A, antenna I; B, antenna II, anterior view; C–D, setae of endopod proximal segment; E, distal portion of limb I. Scale bars: 0.1 mm.

Family Bosminidae Baird, 1845 sensu Sars, 1865

11. *Bosmina* (*Sinobosmina*) *fatalis* Burckhardt, 1924

Fig. 15

Synonymy. *Bosmina fatalis* Burckhardt, 1924, p. 235–237, 240–241, Figs 10, 1–17 (except var. *cyanopotamia*); Kořínek 1971, p. 289–292, Figs 9A–F, 10A–G; Chiang & Du 1979, p. 170–172, Fig. 112; Mizuno & Takahashi 1991, p. 153–154, Text-fig.; Kotov 1997, p. 29; Fig. 3; Tanaka 2000, p. 118–120 Figs 7–9; Kotov et al. 2009, p. 14–17, Figs 6–7.

Type locality. Taihu Lake near Shanghai, China (Burckhardt 1924).

Locality in Korea. 4 (see Fig. 1 and Table 1).

Parthenogenetic female. Body relatively short and wide in lateral view, dorsal margin with a weak depression anterior to brood pouch, posterior margin straight, its height less than half of body height, ventral margin almost straight, with a shallow depression anterior to mucro (Fig. 15A). Frontal head pore small, located far from ventral margin of head shield (as seen from anterior side) somewhat dorsally to level of antennular sensory setae (Fig. 15B). Lateral head pore small, ovoid, located in a bifurcation of reticulation near ventral margin of head shield, but not immediately near the margin (Fig. 15C–D). Labrum a fleshy appendage lacking significant projections, distal labral plate small. Ventral valve margin with a series of stout setae on its anterior portion, base of each located on internal surface of valve, "*seta kurzi*" located on internal side of valve anterior to abovementioned depression near mucro, which is strong, relatively long and lacking any incisions (Fig. 15E). Series of minute setules at inner side of valve near posterior valve margin. Postabdomen with width approximately equal along all its length, with ventral (although functionally dorsal) margin almost straight (Fig. 15F). Preanal margin long, slightly convex, with

groups of setules distally. Distal (anal) margin truncated, postero-dorsal angle as a projection. Postanal portion as a cylindrical projection bearing paired postabdominal claws. Each claw regularly bent, with two pectens on concave (dorsal) margin; distal pecten consists of short, fine spinules, while proximal pecten consists of 7–9 rather strong and thin teeth. Postabdominal seta shorter than preanal margin. Antenna I fused with rostrum, rather long, its length from tip to tip of rostrum less then 0.5 body lengths. Antennular (frontal) sensory seta located on rostrum. Free section of antenna I (not incorporated into rostrum) consists of a pre-aesthetasc portion, fused with rostrum, and a slightly bent post-aesthetasc portion (Kotov et al. 2009). Both portions supplied with transverse series of fine denticles. Antenna II typical for the genus, six pairs of thoracic limbs as described by Kotov (1997). Size in our material 0.34–0.40 mm.

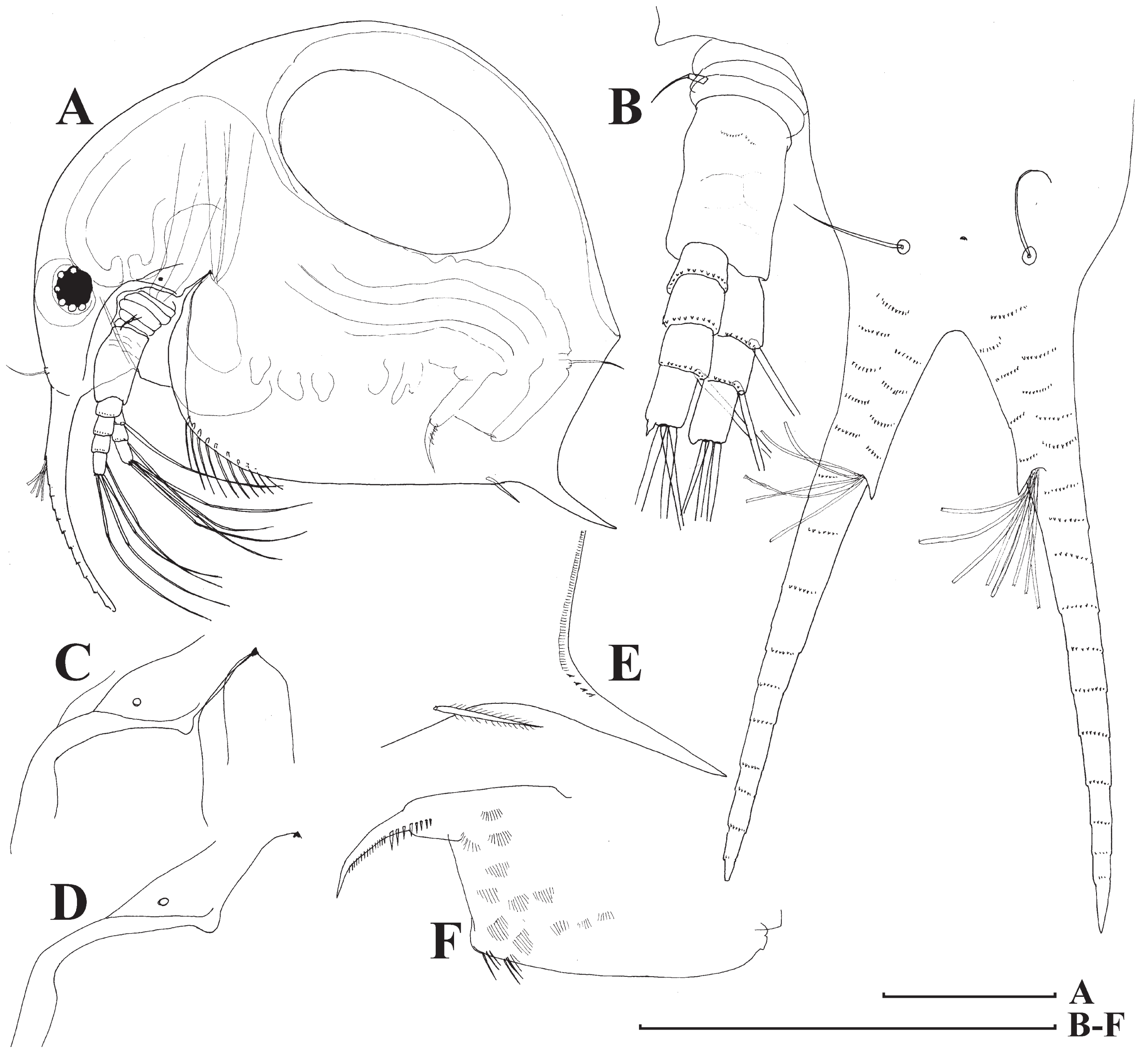

FIGURE 15. *Bosmina fatalis* Burckhardt, 1924, parthenogenetic female from Yong Yeon Ji, locality 4: A, lateral view; B, head, anterior view; C–D, lateral head pore; E, postero-ventral angle of valve, inner view; F, postabdomen. Scale bars: 0.1 mm.

Notes. Kim & Yoon (1987) and Yoon (2010) found only *Bosmina longirostris* (O. F. Müller, 1776) and *B. coregoni* Baird, 1857 in Korea. The most common species is *Bosmina longirostris* (Fig. 16A–C), belonging to the subgenus *Bosmina* (*Bosmina*) Baird, 1845. But in a single locality we found *B. fatalis* belonging to the subgenus *B.* (*Sinobosmina*) Lieder, 1957. It differs in: (1) position of lateral head pore not immediately near the margin of head shield; (2) uniform thin setules in distal pecten on postabdominal claw. Even stronger differences are present between males of the two species (Kotov et al. 2009), but, unfortunately, males of *B.* (*S.*) *fatalis* are unknown from Korea, while males of *B. longirostris* were described by Yoon (2010).

B. (*S.*) *fatalis* is common in the eastern half of China, Far East of Russia, Japan, Philippines, Cambodia and Thailand (Chiang & Du 1979; Mizuno & Takahashi 1991; Maiphae et al. 2008; Kotov et al. 2009; Tanaka & Ohtaka 2010), and its presence in Korea was quite expected. This taxon is a Far Eastern endemic.

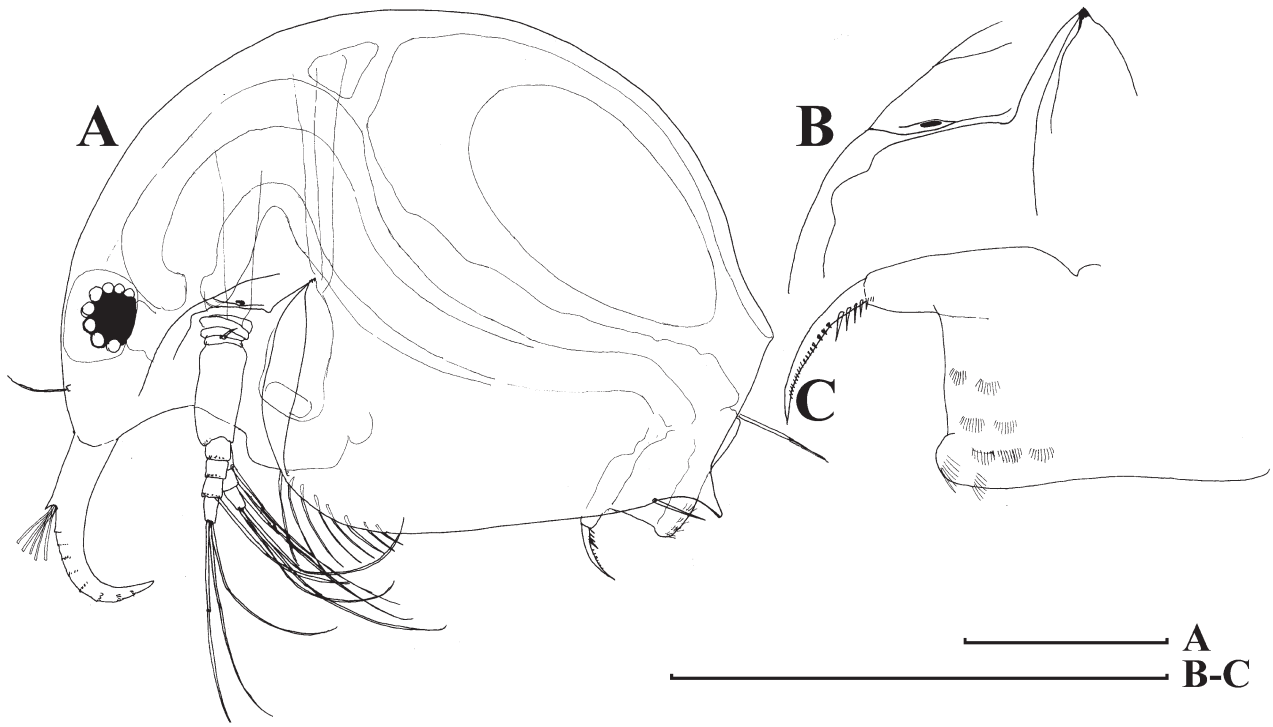

FIGURE 16. *Bosmina longirostris* (O. F. Müller, 1776), parthenogenetic female from Nu Gyo Ri, locality 19: A, lateral view; B, lateral head pore; C, postabdomen. Scale bars: 0.1 mm.

Family Chydoridae Dybowski & Grochowski, 1894 emend. Frey 1967
Subfamily Chydorinae Dybowski & Grochowski, 1894 emend. Frey 1967

12. *Chydorus irinae* Smirnov & Sheveleva, 2010
Fig. 17

Synonymy. *Chydorus irinae* Smirnov & Sheveleva, 2010, p. 635–637, Figs 1–2; Kotov et al. 2011a, p. 406.

Type locality. "Mouth of the Tom' River" (Smirnov & Sheveleva 2010), Amur Area, Russia.

Locality in Korea. 6a (see Fig. 1 and Table 1).

Parthenogenetic female. In lateral view, body very high, "humped", as Smirnov & Sheveleva (2010) (Fig. 17A). Body with strong lateral outgrowths in level of brood pouch (Fig. 17B), in anterior view these "wings" rounded-triangle in adults (Fig. 17C) and acute in juveniles (Fig. 17K). Dorsal head pores typical for the genus (Fig. 17D–E). Labral keel relatively small, with a rounded apex (Fig. 17F). In anterior portion of valve there is an inner flap-like projection (Fig. 17G); reticulation on valves as polygons with rounded angles and undulated edges. In posterior half of ventral margin, setae remarkable submarginally; in posterior portion of valves there are successive series of fine setules (Fig. 17H–I). Postabdomen elongated, ventral margin concave, preanal margin concave, preanal angle strongly projected, anal margin concave, postanal margin straight, dorso-distal angle widely rounded, distal margin short, postabdominal claw located on a massive projection (Fig. 17J). Postanal teeth thin, singular, present on postanal and anal margin; lateral setules longer in distal portion. Postabdominal claw with two basal spines, a strong distal basal spine (about 0.3 of claw length) and a short proximal spine (more than two times shorter than distal spine). Antenna I with 9 terminal aesthetascs. Antenna II as in *Chydorus sphaericus*. Limbs were not studied. Size in our material 0.31–0.37 mm.

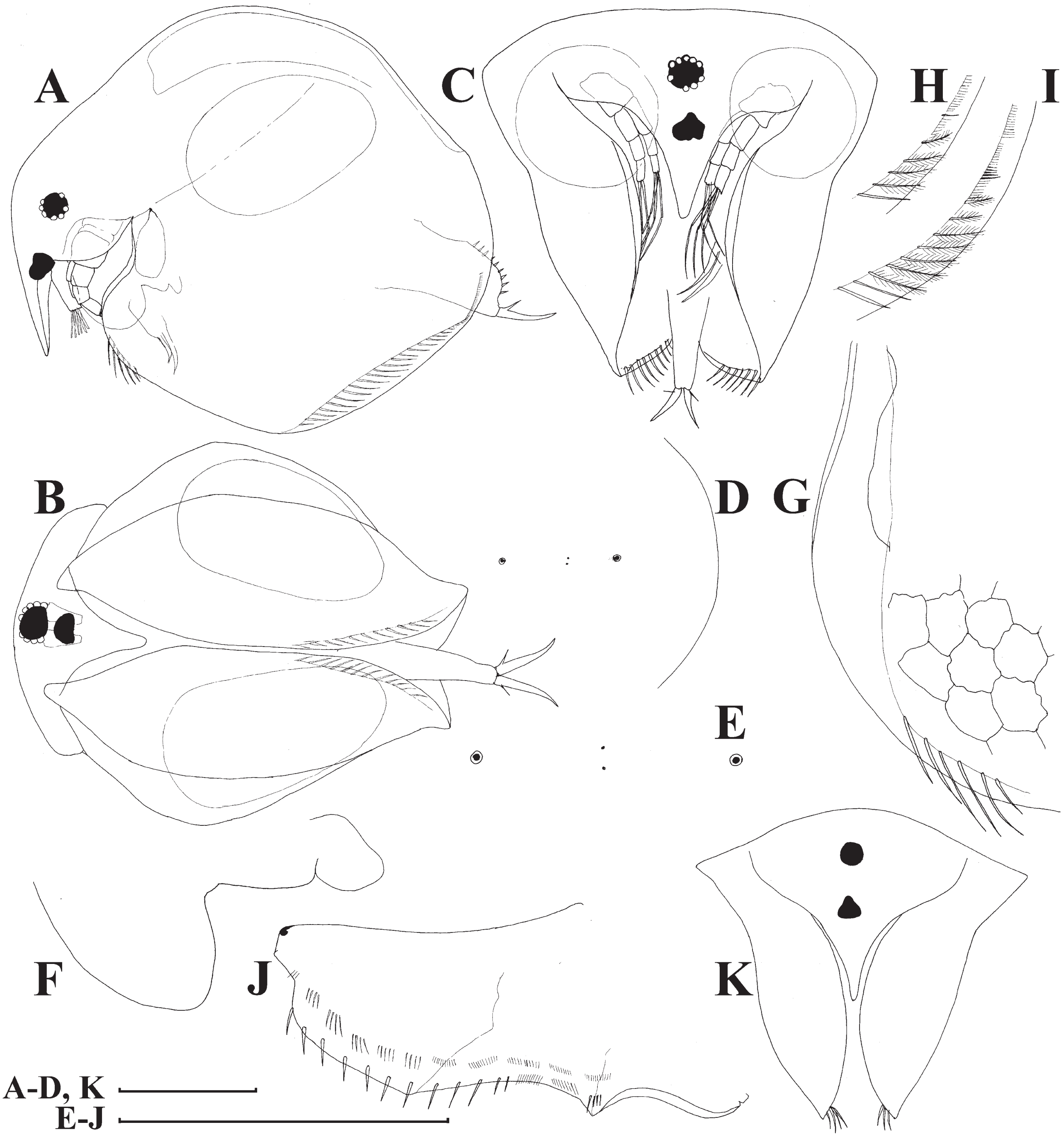

FIGURE 17. *Chydorus irinae* Smirnov & Sheveleva, 2010, parthenogenetic female from Bak Sil Ji 1, locality 6a: A–C, adult, lateral, ventral and anterior view; D–E, dorsal head pores; F, labrum; G, anterior portion of valve; H–I, postero-ventral portion of valve, inner view; J, postabdomen; K, juvenile, anterior view. Scale bars: 0.1 mm.

Notes. We found only a single adult and a single juvenile female, not sufficient for a full redescription. Smirnov & Sheveleva (2010) mentioned that in anterior view, the body is "triangular, with maximum width dorsally to the middle height". We found that it is widened dorsally, forming lateral projections as *Disparalona ikarus* or *Monospilus daedalus*. Previously *C. irinae* was known only from a single locality in the Amur basin. Now it is obvious that its range is wider. Unfortunately, it is impossible to associate any previous descriptions and illustrations from the Far East with this taxon due to a "tradition" to study specimens only in lateral view. This taxon seems to be an endemic of the Far East.

13. *Disparalona ikarus* Kotov & Sinev, 2011

Figs 18–19

Synonymy. *Disparalona ikarus* Kotov & Sinev, 2011, p. 272–276, Figs 1–2.
? *Disparalona rostrata* (Koch) in Kim & Yoon 1987, p. 200–202, Fig. 11c–e; Yoon 2010, p. 134–135, fig. 73.

Type locality. "Mouth of the Tom River (51°02.137′N, 127°53.370′E)" (Kotov & Sinev 2011), Amur Area, Russia.

Localities in Korea. 2, 6a (see Fig. 1 and Table 1).

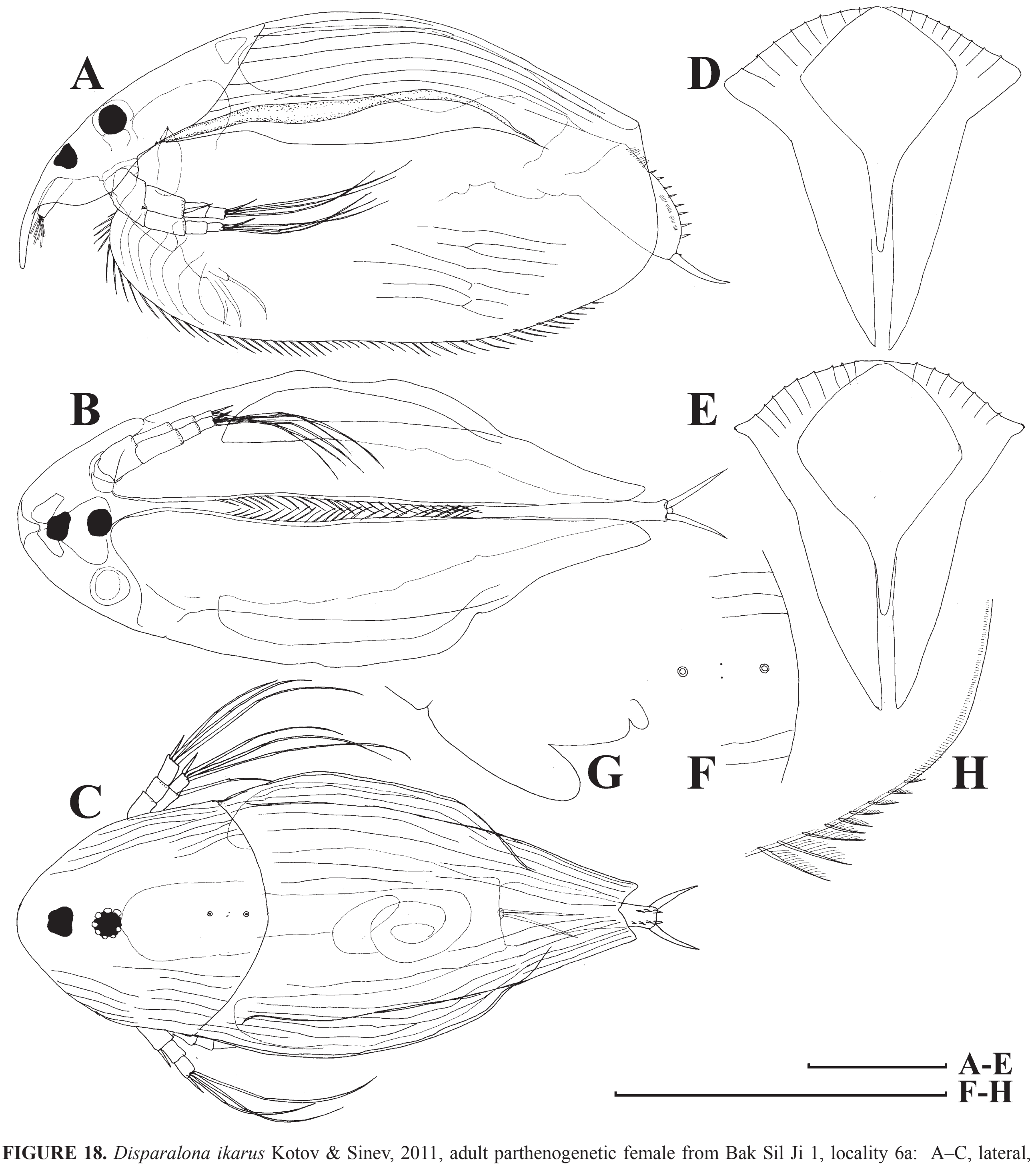

FIGURE 18. *Disparalona ikarus* Kotov & Sinev, 2011, adult parthenogenetic female from Bak Sil Ji 1, locality 6a: A–C, lateral, ventral and dorsal view; D–E, anterior view of two different individuals; F, dorsal head pores; G, labrum; H, postero-ventral valve portion, inner view. Scale bars: 0.1 mm.

Parthenogenetic female. Body moderately elongated for the genus, postero-dorsal angle distinct, lacking any denticles, posterior margin straight, postero-ventral angle widely rounded (Fig. 18A, 19D). A lateral wing-like projection on each side of brood pouch (Fig. 18B–C), in anterior view from rounded-triangular to acute (Fig 18D–E). Sculpture of low longitudinal folds well-expressed in dorsal portion, visible as longitudinal lines in lateral view. Compound eye 2 times larger than ocellus. Dorsal head pores typical for the genus (Fig. 18F). Labral keel relatively narrow, with widely rounded apex (Fig. 18G). In posterior portion of ventral margin, setae located slightly submarginally, no setules between them; a row setules submarginally at posterior margin (Fig. 18H). Postabdomen elongated in both adults in juveniles (Fig. 19A, E), fluently narrowing distally, its length about 3.5 width. Preanal margin straight, preanal angle distinct, anal margin convex, postanal margin regularly curved to the base of postabdominal claw; dorso-distal angle and distal margin not expressed. About 7–8 long and thin singular postanal teeth, rows of setules on anal margin; setules in lateral series short. Postabdominal claw somewhat curved, as long as preanal margin, with a very short basal spine and an additional setule. Antenna I (Fig. 19B) and II typical for genus. Limb I with ODL bearing a single seta, IDL with two long setae setulated distally and a short seta with pointed tip (Fig. 19C). Size in our material 0.35–0.48 mm.

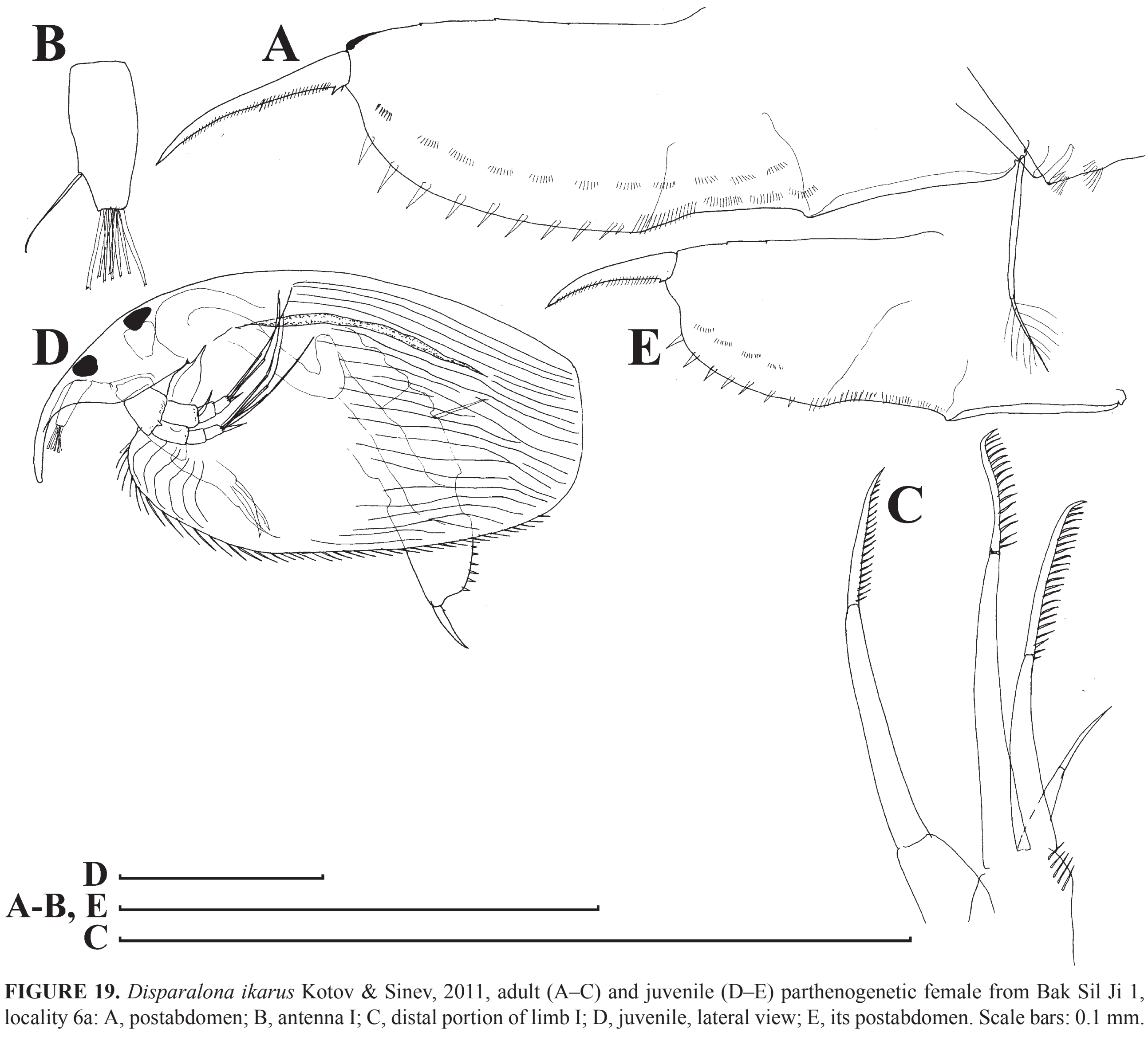

FIGURE 19. *Disparalona ikarus* Kotov & Sinev, 2011, adult (A–C) and juvenile (D–E) parthenogenetic female from Bak Sil Ji 1, locality 6a: A, postabdomen; B, antenna I; C, distal portion of limb I; D, juvenile, lateral view; E, its postabdomen. Scale bars: 0.1 mm.

Notes. This taxon was known from a single locality in the Amur basin. Now it is obvious that it is more widely distributed in the Far East, although the most common species there is *D. cf. hamata* (Birge, 1879) (Fig. 20A–D). *Disparalona ikarus* differs from the latter in: (1) presence of lateral "wings"; (2) absent striae between reticulation lines; (3) weak dorso-distal angle and distal margin of postabdomen; (4) short basal spines on postabdominal claw;

(5) absence of a strong hook-like seta on IDL. Although Kim & Yoon (1987) and Yoon (2010) illustrated their "*Disparalona rostrata*" only in lateral view, we can conclude that, most probably, they were dealing with *D. ikarus,* keeping in mind differences between these two species in shape and armature of the postabdomen.

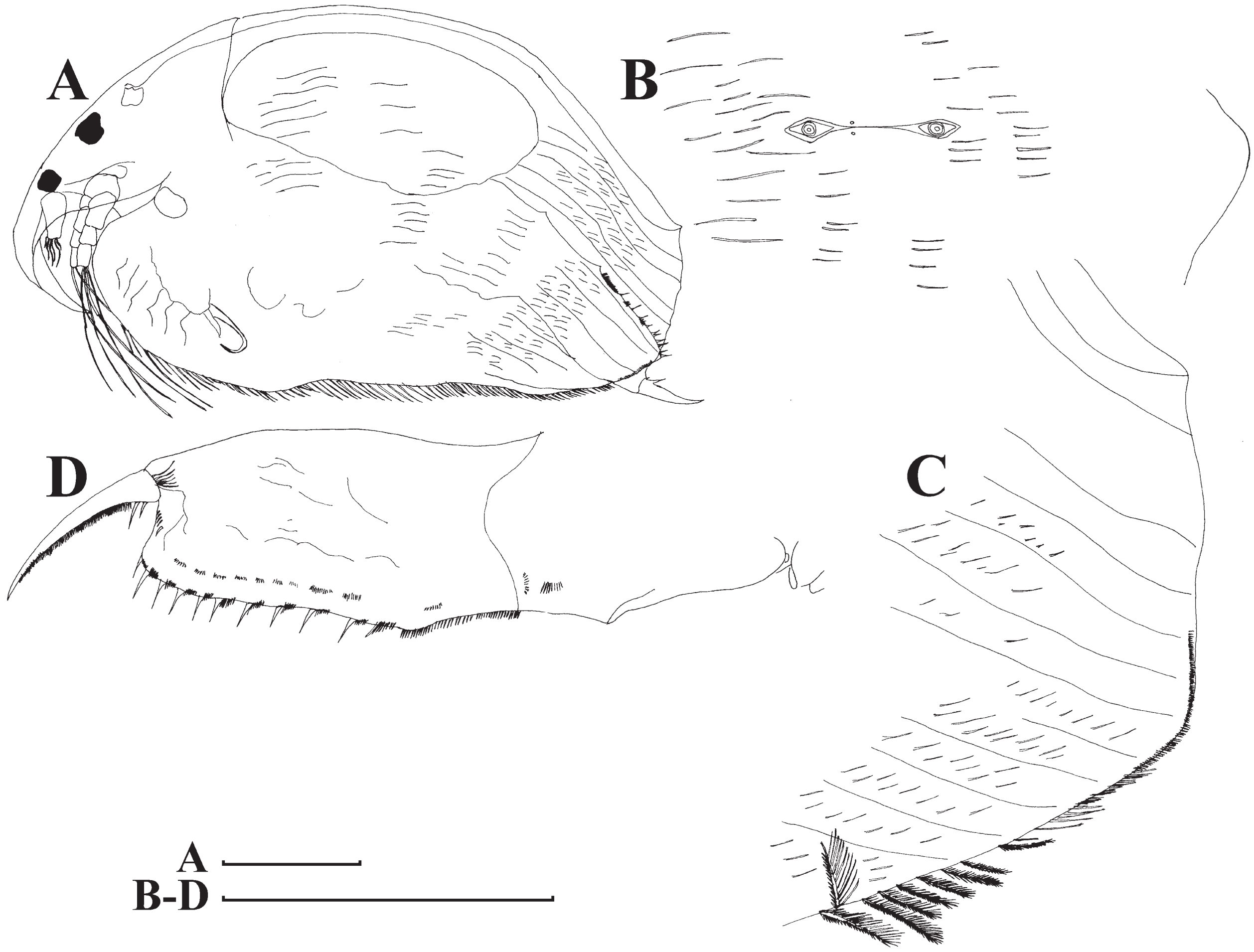

FIGURE 20. *Disparalona cf. hamata* (Birge, 1879), parthenogenetic female from Bak Sil Ji 1, locality 6a: A, lateral view; B, dorsal head pores; C, postero-ventral portion of valve; D, postabdomen. Scale bars: 0.1 mm.

14. ***Ephemeroporus cf. barroisi*** **(Richard, 1894)**

Locality in Korea. 6a (see Fig. 1 and Table 1).

Notes. A single female from Bak Sil Ji was undistinguishable from one earlier found in the Amur basin (Kotov et al. 2011b), most probably the northernmost limit of its distribution. Similar forms are present in China (Chiang & Du 1979). Frey (1982b) regarded *E. barroisi* as *nomen dubium*, but Smirnov (1996) redescribed this species and concluded that it is widely distributed in the tropics of thr Old World. Both females from the Amur basin and Korea are similar with those described by Alonso (1987) as *E.* sp. from Iran, which is, most probably, *E. barroisi* s.str. A recent attempt of redescription of the latter (Yalim & Ciplak 2010) was not very successful, and the taxon needs to be re-investigated in more detail. This is the first record of the genus *Ephemeroporus* Frey, 1982 for Korea.

Subfamily Aloninae Dybowski & Grochowski, 1894 *emend.* Frey, 1967

15. *Camptocercus uncinatus* Smirnov, 1971
Fig. 21

Synonymy. *Camptocercus uncinatus* Smirnov, 1971, p. 436–438, Figs 128, 532; Smirnov 1998, p. 76–77, Figs 51–57; Kotov et al. 2011a, p. 407.
Camptocercus rectirostris (Schoedler) in Kim 1988, Figs 58–59.

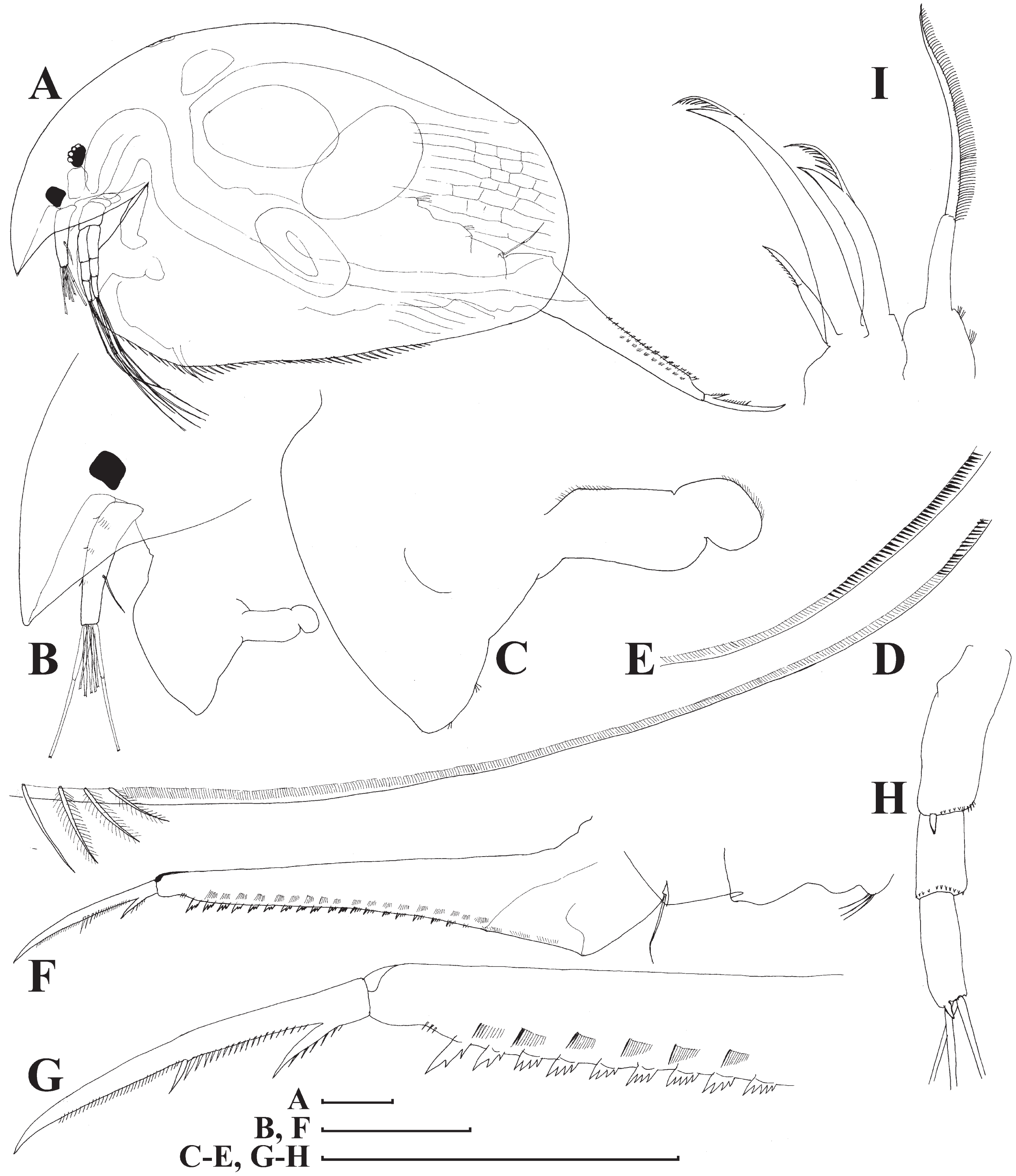

FIGURE 21. *Camptocercus uncinatus* Smirnov, 1971, parthenogenetic female from Bak Sil Ji 1, locality 6a: A, lateral view; B, head; C, labrum; D, armature of postero-ventral valve margin, inner view; E, armature of posterior valve margin, inner view; F, postabdomen; G, postabdominal claw; H, exopod of antenna II; I, distal portion of limb I. Scale bars: 0.1 mm.

Type locality. "Lake Nikolaevskoe (Chita region)", Russia (Smirnov 1971, 1998).

Localities in Korea. 6a, 8 (see Fig. 1 and Table 1).

Parthenogenetic female. Body ovoid, elongated in lateral view (Fig. 21A); strongly compressed laterally and having a well-expressed dorsal keel both on carapace and head. Dorsal margin without depression between valves and head shield, postero-dorsal angle broadly rounded, posterior margin convex, postero-ventral angles broadly rounded. Ventral margin slightly undulated. Rostrum acute, pointed downward (Fig. 21B). Three connected main head pores, lateral pores minute. Labrum with a sub-triangular keel; its posterior margin without a denticle, with two groups of fine setules (Fig. 21B–C). Row of ventral setae followed by a row of fine setules, in dorsal portion of posterior margin they are strong, denticle-like (Fig. 21D–E). Postabdomen very long, narrowing distally, length about 5–6 height (Fig. 21F). Preanal portion almost straight, preanal angle well-developed, anal margin almost straight, postanal angle not expressed, postanal margin straight to slifhtly concave; postanal portion 3–4 times longer than anal one. Postanal margin with about 20 clustered postanal denticles with fused bases (Fig. 21G). Laterally series of fine setules. Postabdominal claw long, straight, with slightly curved tip; basal spine short, slightly bent, about 0.25 length of claw; few setules at the end of proximal pecten as strong spines (Fig. 21G). Antenna I with length about 4–5 width, with three groups of fine setules at anterior face; among nine aesthetascs two longer than the rest, longest aesthetascs as long as antenna I; antennular seta thin, about 1/3 length of antenna I, protruding somewhat distally to middle (Fig. 21B). Antenna II short, antennal formula: setae 0-0-3/0-1-3, spines 1-0-1/0-0-1. Apical setae subequal in size, apical spines very short, spine on proximal exopod segment also very short (Fig. 21H). Limb I with ODL bearing a long seta, armed with long setules; IDL with three setae, seta 1 large, well developed, about 1/3 length of ODL seta; setae 2 and 3 thick, curved, hook-like, with a short, setulated distal portion (Fig. 21I). Size in our material 0.71–0.80 mm.

Notes. Yoon (2010) recorded only *C. rectirostris* Schödler, 1862 from Korea but as his illustrations lack denticles on postero-ventral angle of valve, this is not *rectirostris*, but *C. vietnamensis* Than, 1980. We did not see the former in Korea, but found two other species: *C. uncinatus* Smirnov, 1971 and *C. vietnamensis* Than, 1980. Earlier Kim (1988) misidentified *C. uncinatus* from Korea as *C. rectirostris*.

According to Smirnov (1998), *C. uncinatus* is distributed in southern Europe, Israel, Iraq, Egypt, Ethiopia, Rift Valley in Africa, South West Siberia, Central Yakutia and Central America. The American populations most probably belong to a separate species. In general, *C. uncinatus* occupies the southern Palaearctic. It is recorded from the Amur basin (Kotov et al. 2011a), where *C. rectirostris* and *C. fennicus* Stenroos, 1898 s. lat. are also present. At the same time, its presence in tropical Vietnam, Cambodia and Thailand were put in doubt by Sinev (2011), see next section.

16. *Camptocercus vietnamensis* Than, 1980

Fig. 22

Synonymy. *Camptocercus vietnamensis* Than in Than et al., 1980, p. 233–234, Fig 144; Sinev 2011, p. 52–58, Figs 1–2. *Camptocercus rectirostris* (Schoedler) in Yoon 2010, p. 118–119, Fig. 63.

Type locality. "Hanoi region", Vietnam.

Locality in Korea. 14 (see Fig. 1 and Table 1).

Parthenogenetic female. Body ovoid, high in lateral view (Fig. 22A); strongly compressed laterally and having a well-expressed dorsal keel both on carapace and head. Dorsal margin without depression between valves and head shield, postero-dorsal angle broadly rounded, posterior margin convex, postero-ventral angles broadly rounded. Ventral margin almost straight. Rostrum acute, pointed downward (Fig. 22B). Three connected main head pores, lateral pores minute. Labrum with sub-triangular keel with rounded apex; its posterior margin with denticle and a group of fine setules (Fig. 22B–C). Row of ventral setae followed by a row of fine setules, in dorsal portion of posterior margin they are strong, denticle-like (Fig. 22D). Postabdomen very long, narrowing distally, length about 4.5–5 height (Fig. 22E). Preanal portion straight, preanal angle well-developed, anal margin concave, postanal angle expressed, postanal margin straight; postanal portion 2.5 times longer than anal one. Postanal margin with 15–18 small triangular, postanal denticles, each distal one with a small additional denticle proximally to its base. Laterally, about 15 lateral series of fine setules. Postabdominal claw long, straight , with slightly curved tip; basal spine short, slightly bent, about 0.2 length of claw itself; setules at the end of proximal pecten as strong

spines (Fig. 22F). Antenna I with length about 4–5 width, with three groups of fine setules at anterior face; among nine aesthetascs two longer than the rest, longest aesthetascs as long as antenna I; antennular seta thin, about 1/3-1/4 length of antenna I, protruding somewhat distally to middle (Fig. 22B). Antenna II short, antennal formula: setae 0-0-3/0-1-3, spines 1-0-1/0-0-1. Apical setae subequal in size, apical spines very short, spine on proximal exopod segment also very short (Fig. 22G). Limb I with ODL bearing a long seta, armed with long setules; IDL with four clusters of setules and three setae; seta 1 large, well developed, about 1/3 length of ODL seta; setae 2 and 3 thick, curved, hook-like, with a setulated distal portion (Fig. 22H). Size in our material 0.39–0.50 mm.

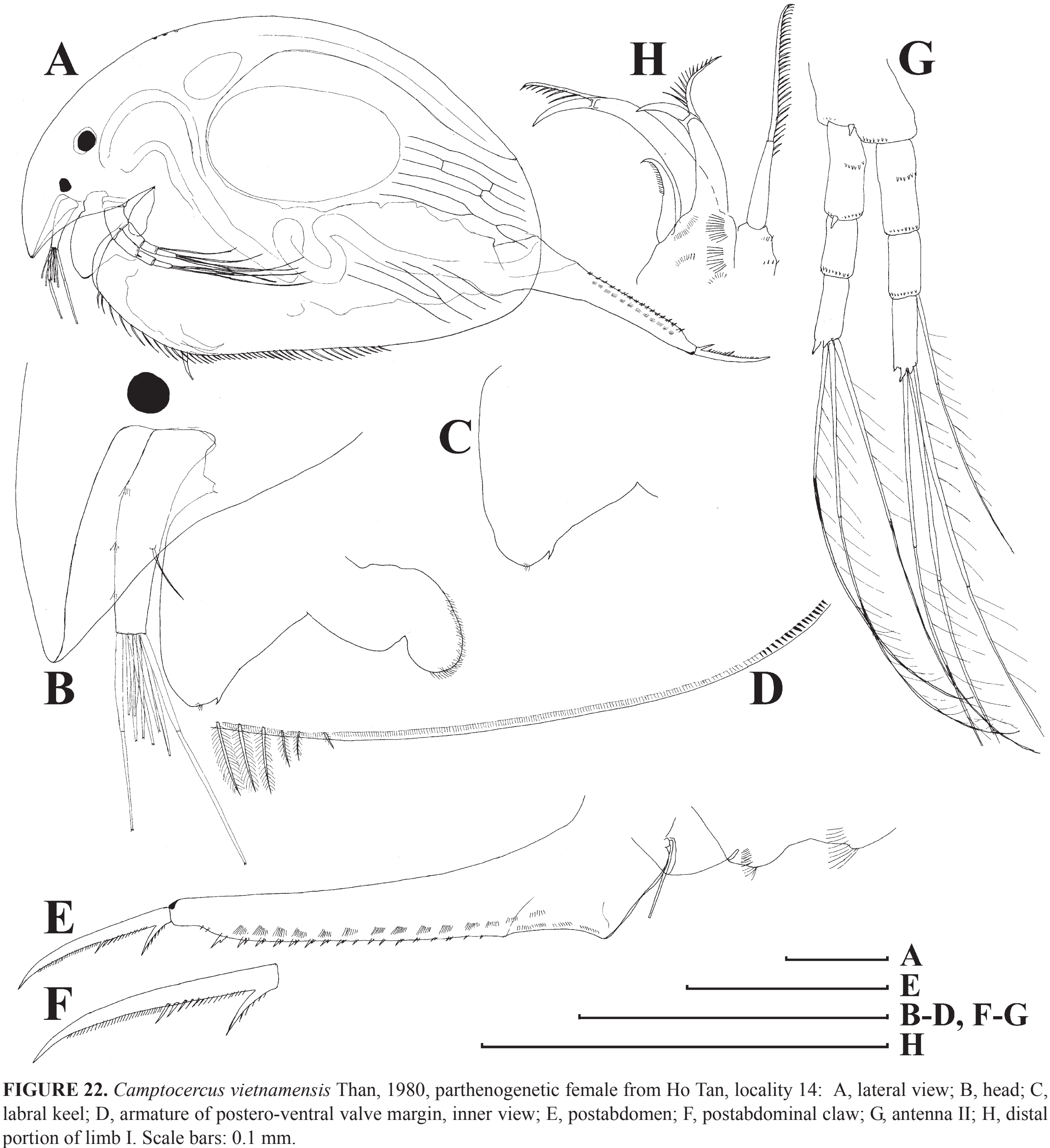

FIGURE 22. *Camptocercus vietnamensis* Than, 1980, parthenogenetic female from Ho Tan, locality 14: A, lateral view; B, head; C, labral keel; D, armature of postero-ventral valve margin, inner view; E, postabdomen; F, postabdominal claw; G, antenna II; H, distal portion of limb I. Scale bars: 0.1 mm.

Notes. *Camptocercus vietnamensis* differs from *C. uncinatus* in: (1) a smaller size (Sinev 2011), although such comparison should be based on ample samples; (2) higher body; (3) presence of a denticle on labral keel; (4) postanal teeth consisting of a strong denticle and one small additional denticle proximally to its base. Until recently it was known only from Vietnam, but Sinev (2011) proposed that some tropical populations earlier identified as *C.*

uncinatus could also belong to *C. vietnamensis*. It is a rheophylic species (Sinev 2011), but we found it in an oxbow lake. After our finding, it is clear that it is widely distributed in Pacific Asia. We regard it as a tropical-subtropical species that deeply penetrating the Palaearctic. Korea may be the northernmost area of its distribution, because it is apparently absent from the Amur basin (Kotov et al. 2011a).

17. *Kurzia* (*Rostrokurzia*) *longirostris* (Daday, 1898)

Fig. 23

Synonymy. *Alona longirostris* Daday, 1898, p. 34–35, Fig. 14a–c.
Kurzia longirostris (Daday) in Rajapaksa & Fernando 1986, p. 2590–2595, Figs 1–50; Hudec 2000, p. 175–176, Figs 35–44.

Type locality. "Colombo (Beira) Lake, Colombo"(Rajapaksa & Fernando 1986).

Locality in Korea. 8 (see Fig. 1 and Table 1).

FIGURE 23. *Kurzia* (*Rostrokurzia*) *longirostris* (Daday, 1898), parthenogenetic female from Bak Sil Ji 3, locality 8: A, lateral view; B, head; C, postabdomen; D–E, distal portion of limb I. Scale bars: 0.1 mm.

Parthenogenetic female. Body ovoid, high in lateral view, dorsal margin regularly curved from tip of rostrum to slightly expressed postero-dorsal angle, posterior margin convex, postero-ventral angle broadly rounded, ventral margin with a prominence anteriorly to middle (Fig. 23A). Body compressed laterally, with a medial keel on carapace, but not on head. Rostrum long, ocellus about half size of compound eye (Fig. 23B). Three major head pores connected, posterior pore transversely elongated, lateral pores minute. Labrum with large, triangular labral keel, anterior margin, its apex with a small hillock (Fig. 23B). Submarginal setules on posterior margin subequal in size. Postabdomen elongated, with concave postanal margin; dorso-distal angle of postabdomen remarkably projected; postanal teeth about 9–11, relatively robust in distal portion of the postabdomen (Fig. 23C). Postabodminal claw long, slightly curved, with a single short basal spine (as long as claw width), bearing a series of 5–6 thin spinules. Antenna I elongated, sensory seta in middle, nine aesthetascs of unequal size, three longest ones almost reaching tip of rostrum (Fig. 23B). Antenna II short, antennal formula: setae 0-0-3/1-1-3, spines 1-0-1/0-0-1. Limb I with ODL bearing a single bisegmented seta, setulated distally (Fig. 23D), IDL with three setae, the shortest seta unilaterally setulated, other two setae heavily chitinized, hook-like, with additional teeth on proximal portion; distal portion with a row of setules decreasing to tip (Fig. 23D–E). Size in our material 0.50–0.62 mm.

Notes. Rajapaksa & Fernando (1986) concluded that *K. longirostris* is found in Australia, Bangladesh, Burma, Ghana, Guatemala, India, Indonesia, Malaysia, Nigeria, Papua New Guinea, Paraguay, Philippines, Tanzania, and Thailand. It also occurs in some other tropical and subtropical countries, i.e., Israel (Bromley 1993), Chad (Rey & Saint-Jean 1968), Sudan (Green 1984), Mexico (Van de Velde et al. 1978) and Cambodia (Tanaka & Ohtaka 2010), making it a tropical-subtropical taxon. We found it far north from the tropics, and Korea is, most probably, the northernmost area of its distribution. *Kurzia longirostris* is definitively absent in Far East of Russia, while *K. cf. latissima* is common in the area of Lake Khanka (Kotov, unpublished) and is also known for China (Chiang & Du 1979). This is the first record of the genus *Kurzia* for Korea.

18. *Leydigia* (*Neoleydigia*) *acanthocercoides* (Fischer, 1854)
Fig. 24

Synonymy. *Lynceus acanthocercoides* Fischer, 1854, p. 431–433, Pl. 3: Figs 21–25.
Leydigia acanthocercoides (Fischer) in Lilljeborg 1901, p. 499–502, Pl. 71: Figs 4–8; Smirnov 1971, p. 458–460, Figs 569–570 (only Europe!); Flössner 1972, p. 327–329, Fig. 154; Flössner 2000, p. 355–357, Fig. 131A–G; Kotov et al. 2003, p. 196, Figs 86–90; Kotov, 2009, p. 48–53, Fig. 224–261.
See extensive synonymy in Kotov (2009).

Type locality. Fischer's material was from "stehenden Wässern der Insel Madeira, als auch in solchen bei Iwanofskoje in Gouvernment Tambow" (Fischer 1854), the latter is in European Russia.

Locality in Korea. 8 (see Fig. 1 and Table 1).

Parthenogenetic female. Body triangular-ovoid, dorsal margin slightly and uniformly curved from tip of rostrum to smooth postero-dorsal angle; posterior margin convex (Fig. 24A). Coarse striation non-distinct, fine striation very distinct, see Kotov 2009. Head small, compound eye small, ocellus slightly larger (Fig. 24B). Three large head pores on area devoid of reticulation. Labral keel widely-triangular-ovoid, with distinct apex, its anterior margin with fringe of long setules, 4–5 lateral groups of fine setules. In anterior portion of the ventral margin setae longer (Fig. 24C). On posterior margin, a row of setules on inner side of valve, located far from margin, they are larger that 'setules' of marginal membrane (see Kotov 2009). Postabdomen broad, subovoid, robust, preanal margin shorter than anus, with 3 relatively large projections in basal 2/3, preanal and postanal angles well defined, no distal margin and no dorso-distal angle (fig. 24D). Postanal marginal denticles in numerous clusters, size increasing distally in each cluster, 10–12 fascicles of stout lateral setae, decreasing in size basally, 3–4 setae in each fascicle on distal portion, only 2 setae in each fascicle in middle. Postabdominal claw slightly shorter than preanal plus anal portion of postabdomen, slightly curved, basal spine rudimentary or absent (Fig. 24E). Antenna I not reaching tip of rostrum, with 4 transverse rows of setules at anterior face and series of short setules at tip. Sensory seta arising about 1/4 of way from tip. Largest aesthetasc less than half length of appendage. Antenna II with few stout spine-like setules on first and second endopod segments; a strong spine on proximal segment of exopod longer that the next segment (Fig. 24F). Distal lateral seta short, basal lateral seta as long as apical seta. Limbs as described by Kotov (2009). Size in our material 0.6 mm.

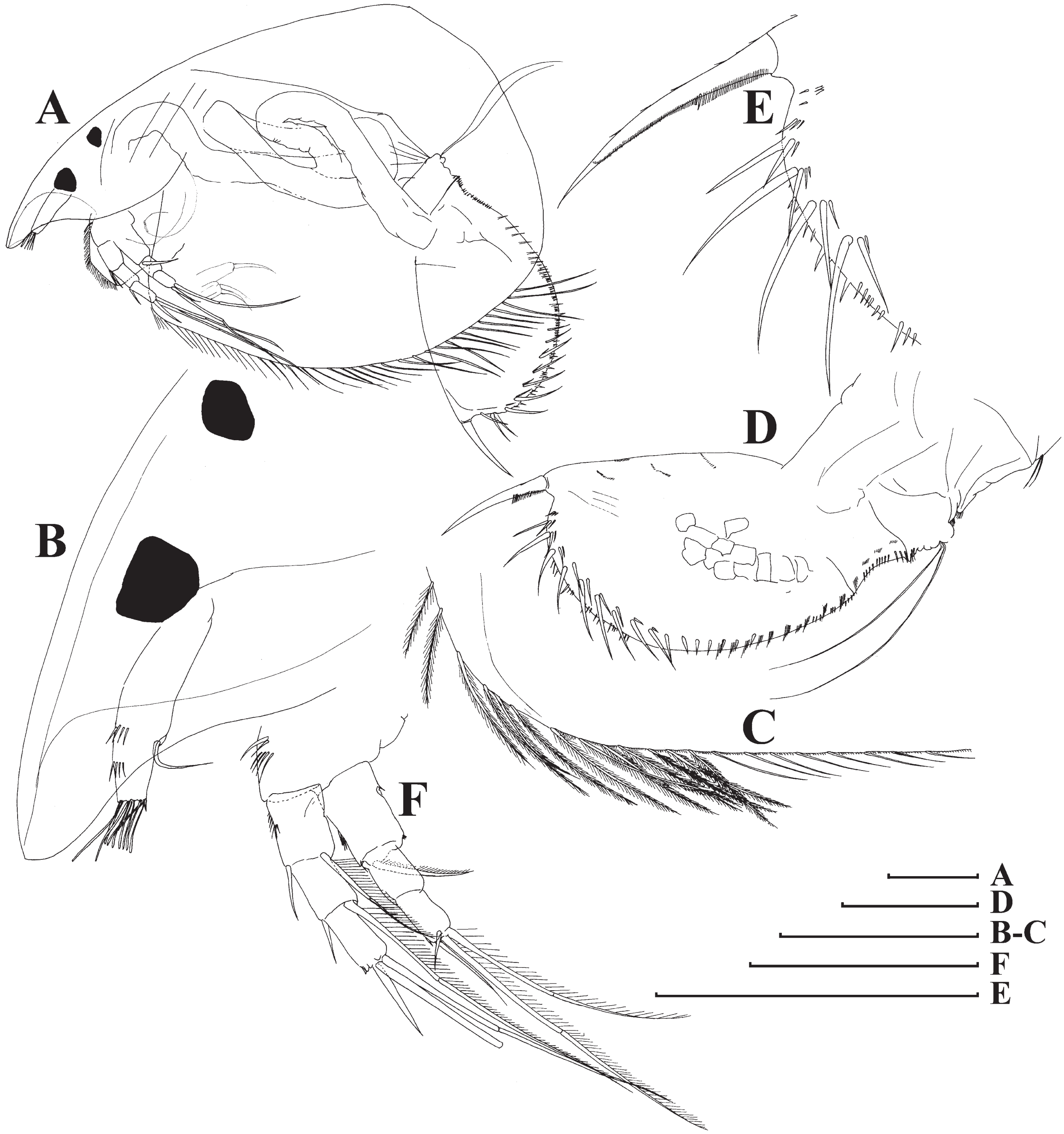

FIGURE 24. *Leydigia* (*Neoleydigia*) *acanthocercoides* (Fischer, 1854), parthenogenetic female from Bak Sil Ji 3, locality 8: A, lateral view; B, head; C, ventral margin of valve; D, postabdomen; E, its distal portion; F, antenna II. Scale bars: 0.1 mm.

Notes. *Leydigia acanthocercoides* differs from *L. ciliata* Gauthier, 1939 in (1) relatively wide postabdomen and (2) predominantly doubled, not tripled, lateral setae of the middle portion of postanal margin. The latter is a tropical-subtropical species (Kotov et al. 2003) also present in Korean Peninsula and well illustrated by Yoon & Kim (1993) and Yoon (2010). The status of Asian "*L. ciliata*" needs to be checked, because Sinev & Sanoamuang (2011) revealed some differences in male morphology between Asian and African populations.

About *L. acanthacercoides* Kotov (2009) mentioned that "At present I can confirm the presence of this species only in Europe and northern Asian Russia ('Siberia')". The *acanthocercoides*-group needs to be revised. Recently Kotov & Alonso (2010) demonstrated that in the Iberian Peninsula there are two species earlier identified as "*L. acanthocercoides*" (i.e. in Alonso, 1996). Our superficial examination of a single Korean population did not reveal any differences from the European populations. So, Korea might be the most southern limit of *L. acanthocercoides'* distribution. Among specimens illustrated from China under different names *L. acanthocercoides* was not found, but *L. ciliata* is present (Chiang & Du 1979, Fig. 139–140, 142).

19. *Monospilus daedalus* Kotov & Sinev, 2011
Fig. 25

Synonymy. *Monospilus daedalus* Kotov & Sinev, 2011, p. 276–280, Figs 3–4.

Type locality. "Mouth of the Tom' River" (Kotov & Sinev 2011), Amur Area, Russia.

Locality in Korea. 12 (see Fig. 1 and Table 1).

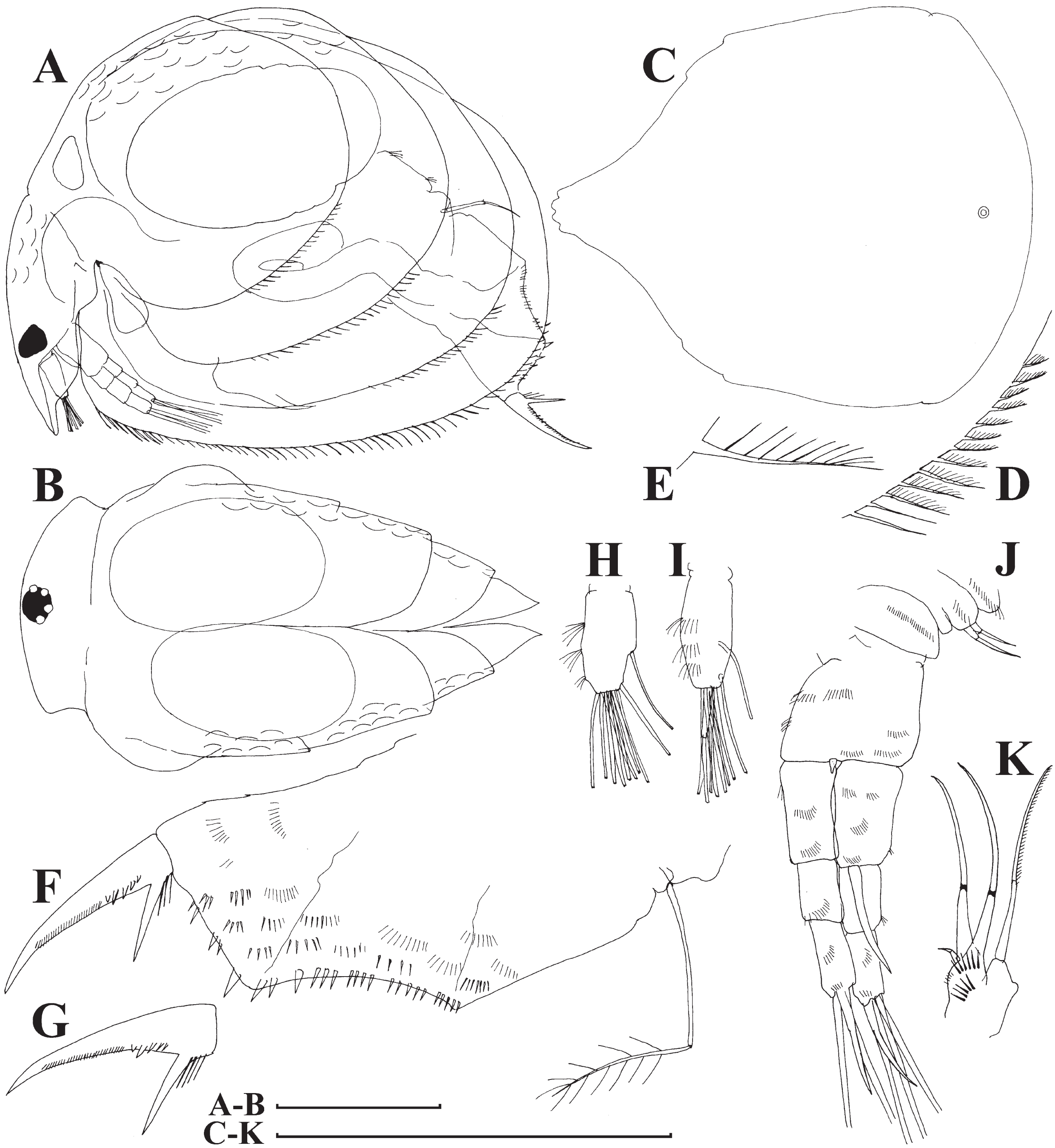

FIGURE 25. *Monospilus daedalus* Kotov & Sinev, 2011, parthenogenetic female from Cheok Ji Ri, locality 12: A, lateral view; B, dorsal view; C, head shield; D, armature of postero-ventral valve margin, inner view; E, seta on postero-ventral angle; F, postabdomen; G, postabdominal claw; H–I, antenna I, lateral and anterior view; J, antenna II; K, distal portion of limb I.
Scale bars: 0.1 mm.

Parthenogenetic female. Body rounded, very high, moulting incomplete (Fig. 25A). As dorsally, body relatively compressed laterally, with lateral projections in anterior half of the valves of first instar (Fig. 25B). Sculpture with numerous shallow depressions, more expressed in dorsal portion. Rostrum short, compound eye absent, ocellus large. Head shield with step-like incisions on each side in antero-lateral portion, rostrum wide, with four tubercles; single, relatively small major head pore in posterion portion, lateral pores absent (Fig. 25C). Setae on ventral margin of valve short, unilaterally setulated (Fig. 25D–E). Postabdomen short, its length 2–2.5 of width. Preanal margin straight; preanal angle distinct, obtuse; anal margin concave, postanal angle obtuse, massive; postanal margin almost straight, almost no projection for postabdominal claw (Fig. 25F). On postanal and anal margin, 3–6 strong, single postanal teeth, groups on smaller teeth on anal margin. Laterally, several row of spinules. Postabominal claw massive, with two pectens, in proximal pecten distalmost denticle shorther than the second one. Basal spine long, 3–4 thin setules at its base (Fig. 25F–G). Antenna I short, its length 2.5 times of width; antennular sensory seta located somewhat distally to middle, its length subequal to antenna I length; 8 terminal and single lateral easthetascs (Fig. 25H–I). Antenna II short, with two sensory setae at coxal portion; basal segment with a short spine distally (Fig. 25J). Antennal formula: setae 0-0-3/0-1-3, spines 1-0-1/0-0-1. Spine on proximal segment of exopod very long, more that 1.5 times longer than next segment; spines on apical segments about 1.5 times longer than these segments. Six pairs of limbs as it was described by Kotov & Sinev (2011), ODL with a single seta armed with short setules distally; IDL with two setae of subequal size and a third rudimentary seta. (Fig. 25K). Size in our material 0.34 mm.

Notes. The species, known from a single locality in the Amur basin (Kotov & Sinev 2011), clearly has a wider range. Illustrations and descriptions of the Chinese and Japanese populations (Chiang & Du 1979; Mizuno & Takahashi 1991) are not detailed enough for evaluating their species status. After the description of *M. daedalus*, all previous identifications of *M. dispar* Sars, 1862 from the Far East, including Korea (Yoon & Kim 1987; Yoon 2010), need to be re-checked.

20. *Nedorchynchotalona chiangi* Kotov & Sinev, 2011
Figs 26–27

Synonymy. *Rhynchotalona falcata* (Sars) in Chiang & Du 1979, p. 231, Fig. 159A–B.
Nedorchynchotalona chiangi Kotov & Sinev, 2011, p. 281–283, Figs 5–6.

Type locality. "River Amur near the mouth of Zeya River in region of Blagoveshchensk town" (Kotov & Sinev 2011), Amur Area, Russia.

Locality in Korea. 6a (see Fig. 1 and Table 1).

Parthenogenetic female. Body low, posterior margin regularly curved from tip of rostrum to rounded postero-dorsal angle lacking any denticles, posterior margin convex, postero-ventral angle broadly rounded (Fig. 26A–B, 27D). Body moderately compressed laterally (Fig. 27E). Head with regularly curved, elongated rostrum (three times longer than antenna I), ocellus and compound eye of similar size (Fig. 26C). Head shield without any dorsal head pores (Fig. 27E). Labral keel relatively small, with regularly curved or slightly undulated anterior margin and rounded apex (Fig. 26C–D, 27F). Valves with 35–40 setae, first 7–9 setae very long, posterior setae slightly submarginal, with short setules between them; a row of delicate setules located far from posterior margin on inner face of valve (Fig. 26E); strong striation in dorsal portion of valves. Postabdomen regularly widened in distal portion, ventral margin straight, preanal margin 1.5 times longer than anal one, slightly undulated; preanal angle well-expressed; anal margin concave; postanal angle expressed; postanal margin convex, dorso-distal angle broadly rounded, distal margin ill-expressed or absent (Fig. 26F–G, 27G). On distal portion, 6–8 clustered postanal teeth and about 7–8 groups of long lateral setules, groups of short setules on anal margin. Postabdominal claw long, slightly curved, length of a single basal spine of 0.2 claw length, 1–2 minute spinules at its base. Antenna I short, with antennular sensory seta approximately in middle, three clusters on setules on antenna I anterior face, terminally, nine terminal aesthetascs, among them two larger than the rest (Fig. 27A). Antenna II short, with two short sensory setae in coxal portion, basal segment with a short spine distally (Fig. 27B, H). Antennal formula: setae 0-0-3/0-1-3, spines 1-0-1/0-0-1; a spine on proximal segment of exopod 1.5 times longer of second segment; apical spines longer apical segments. Five limbs as described by Kotov & Sinev (2011). Limb I with ODL supplied with a single long seta; IDL with two strong setae and a very short seta (Fig. 27C). Size in our material 0.30–0.47 mm.

Notes. The species was known from several localities in Far East of Russia and China. It is probably endemic of the Far East. This is the first record of the genus for Korea.

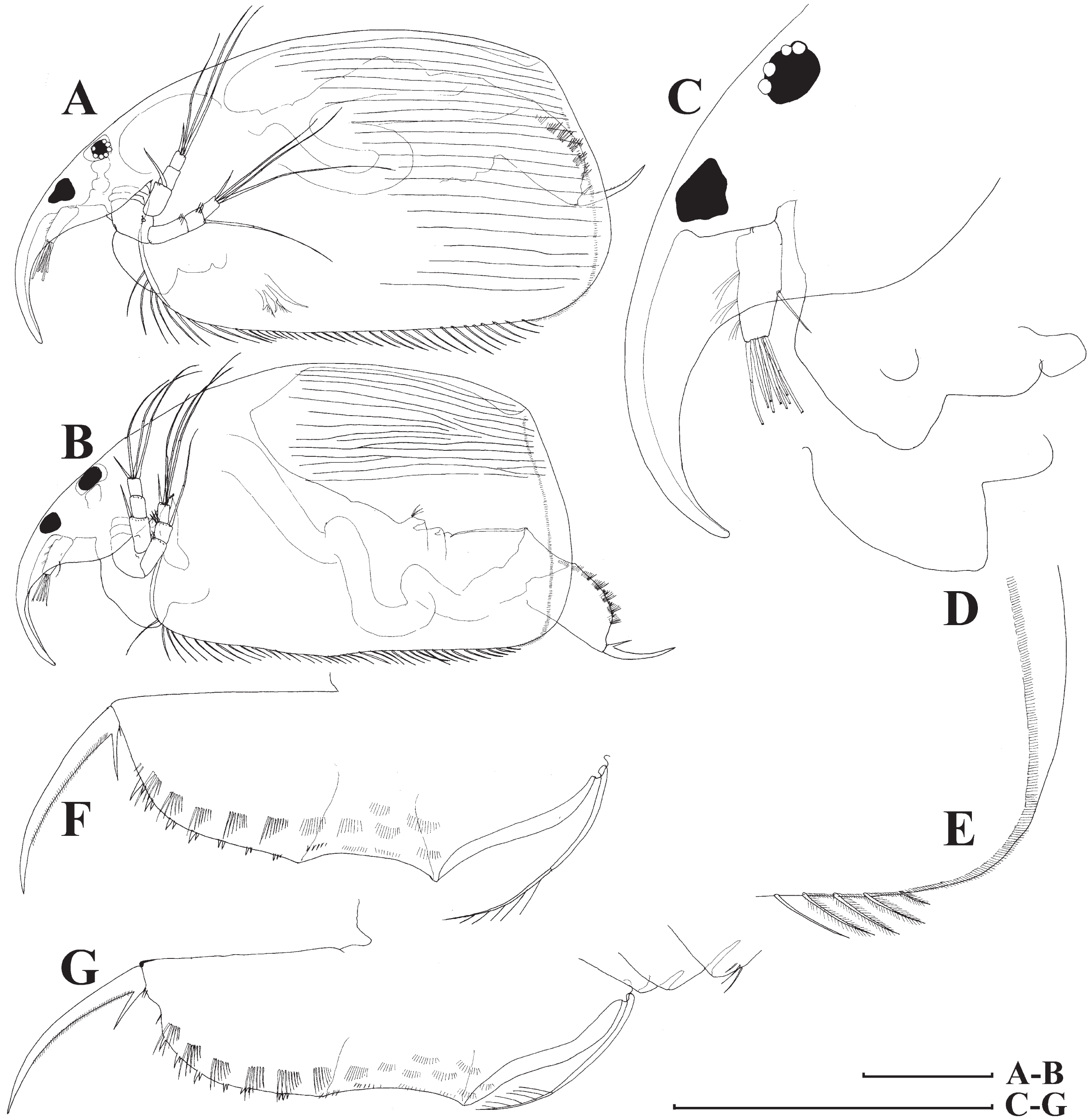

FIGURE 26. *Nedorchynchotalona chiangi* Kotov & Sinev, 2011, adult parthenogenetic female from Bak Sil Ji 1, locality 6a: A–B, lateral view; C, head; D, labrum; E, armature of postero-ventral valve margin, inner view; F–G, postabdomen. Scale bars: 0.1 mm.

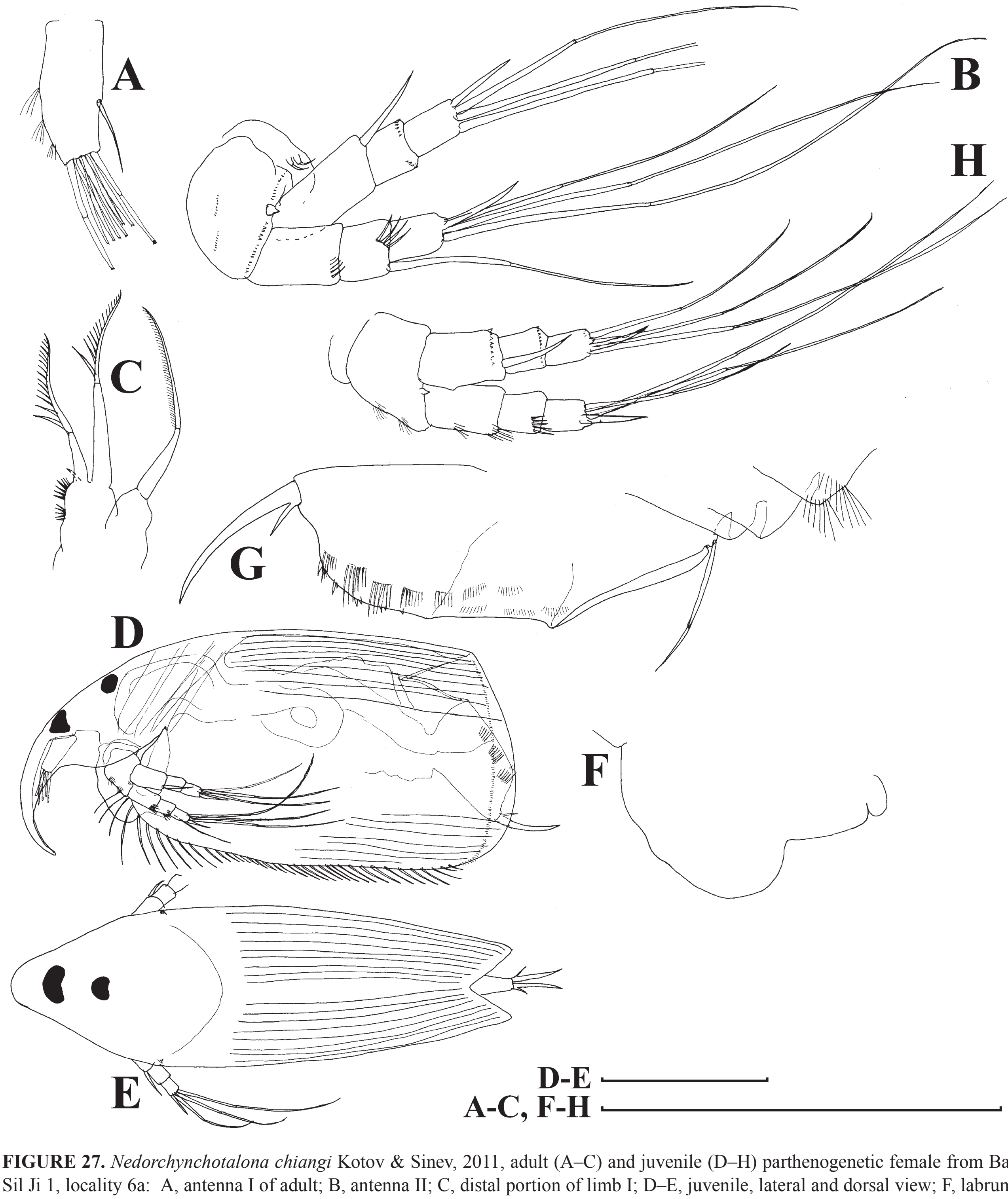

FIGURE 27. *Nedorchynchotalona chiangi* Kotov & Sinev, 2011, adult (A–C) and juvenile (D–H) parthenogenetic female from Bak Sil Ji 1, locality 6a: A, antenna I of adult; B, antenna II; C, distal portion of limb I; D–E, juvenile, lateral and dorsal view; F, labrum; G, postabdomen; H, antenna II of juvenile. Scale bars: 0.1 mm.

Discussion

We subdivided our 20 new records into six main groups (Table 2). These include six endemics of the Far East (sometimes penetrating SW Asia, but absent in more western territories of the Oriental zone like India); five tropicopolitan species (widely distributed in the tropics of the Old World, or even both Old and New World and penetrating the southern Palaearctic) for which the Amur basin is the northernmost range limit; four tropicopolitan

species for which Korea is presumably the northernmost area of their distribution; two Palaearctic taxa for which Korea could be the southernmost area of their distribution; two cosmopolitan species which need to be revised; and one species widely distributed in Eastern Asia.

TABLE 2. Types of distribution of the Korean cladocerans.

	Taxon	Distribution
1	*Sida ortiva* Korovchinsky, 1979	Widely in Eastern Asia
2	*Pseudosida cf. szalayi* (Daday, 1898)	Tropicopolitan, Amur basin is its northern range
3	*Scapholeberis kingi* Sars, 1888	Tropicopolitan, Amur basin is its northern range
4	*Simocephalus congener* (Koch, 1841)	Cosmopolitan, but needs to be revised
5	*Moinodaphnia macleayi* (King, 1853)	Tropicopolitan, Korea is nothern range
6	*Ilyocryptus cuneatus* Štifter, 1988	Northern Palaearctic, Korea is its southern range?
7	*Ilyocryptus cf. raridentatus* Smirnov, 1989	Tropicopolitan, Amur basin is its northern range
8	*Ilyocryptus spinifer* Herrick, 1882	Tropicopolitan, Amur basin is its northern range
9	*Macrothrix pennigera* Shen, Sung & Chen, 1961	Far East endemic
10	*Macrothrix triserialis* Brady, 1886	Tropicopolitan, Korea is northern range
11	*Bosmina* (*Sinobosmina*) *fatalis* Burckhardt, 1924	Far East endemic
12	*Chydorus irinae* Smirnov & Sheveleva, 2010	Far East endemic
13	*Disparalona ikarus* Kotov & Sinev, 2011	Far East endemic
14	*Ephemeroporus cf. barroisi* (Richard, 1894)	Tropicopolitan, Amur basin is its northern range
15	*Camptocercus uncinatus* Smirnov, 1971	Cosmopolitan, but needs to be revised
16	*Camptocercus vietnamensis* Than, 1980	Tropicopolitan, Korea is northern range
17	*Kurzia* (*Rostrokurzia*) *longirostris* (Daday, 1898)	Tropicopolitan, Korea is northern range
18	*Leydigia* (*Neoleydigia*) *acanthocercoides* (Fischer, 1854)	Northern Palaearctic, Korea is its southern range?
19	*Monospilus daedalus* Kotov & Sinev, 2011	Far East endemic
20	*Nedorchynchotalona chiangi* Kotov & Sinev, 2011	Far East endemic

Our study significantly increases the number of endemic Far East taxa (six), and the number of taxa for which Korea is the northernmost border of their range, or located near this border, the Amur basin, which is only about 700–800 km north (five and four species respectively). Our data agree well with the concept of "continental endemism" (Frey 1982a,b), widely accepted by recent investigators (Forró et al. 2008; Xu S. et al. 2009; Adamowicz et al. 2009).

Seven presumed endemics to the Far East were first described from the Amur Basin: (1) *Diaphanosoma amurensis* Korovchinsky & Sheveleva, 2009; (2) *Daphnia sinevi* Kotov, Ishida & Taylor, 2006; (3) *Chydorus irinae* Smirnov & Sheveleva, 2010; (4) *Disparalona ikarus* Kotov & Sinev, 2011; (5) *Monospilus daedalus* Kotov & Sinev, 2011; (6) *Nedorhynchotalona chiangi* Kotov et Sinev 2011; and (7) *Leptodora richardi* Korovchinsky, 2009. In addition, *Alona irinae* Sinev, Alonso & Sheveleva, 2009 is present in the Amur basin, but penetrates the Asian continent quite deep towards the west, reaching its range limit near Lake Baikal (Sinev et al., 2009). Also an undescribed species related to *Daphnia curvirostris* Eylmann, 1887 is found in a few localities near Khabarovsk on the Amur River (Kotov & Taylor, unpublished)

The exact range of these nine taxa is unknown. They have not been found in (1) more northern areas of Russian Siberia, i.e. Central Yakutia, (2) Mongolia in the West (Kotov, unpublished data), and (3) tropical countries in the South, i.e. Thailand (Maiphae et al. 2008), Cambodia (Tanaka & Ohtaka 2010), and Vietnam (Sinev, unpublished). Apparently they are present in China (confirmed only for *Nedorhynchotalona chiangi* by Kotov & Sinev 2011 based on illustrations of Chiang & Du 1979), but recent ranges of their distribution are unknown. So, these taxa form a specific Far East endemic faunistic complex. In this paper, we report on finding this complex in Korea.

We believe that some other Far East endemics will be found in Korea in the future, first of all, *Daphnia sinevi* Kotov, Ishida & Taylor, 2006 (the most common species in temporary waters of Far East of Russia) and *Leptodora richardi* Korovchinsly, 2009. *Leptodora* sp. was collected in Hap Cheon reservoir, but only juvenile females were available, and a conclusion on their status is impossible at this moment.

It is important that molecular phylogenetic studies of different cladoceran taxa reveal usually some specific phylogroups in the Far East of Asia (Kotov et al. 2006; Belyaeva & Taylor 2009; Xu S. 2009; Xu L. 2010; Millette et al. 2011). So, both genetics and morphology agree with a strong endemism in the cladocerans from this region. Japan was even named a "hotspot of endemism" by Kotov et al. (2009). Unfortunately, molecular studies have so far dealt only with a few cladoceran taxa, therefore most part of specific phylogroups is still hidden.

There are many taxa with a “wide distribution", recorded for Korea (Kim 1988; Yoon 2010) and found by us in many localities, which need to be revised, such as *Daphnia galeata*, *Ilyocryptus agilis, Bosmina* (*Eubosmina*) *coregoni, Chydorus sphaericus, Picripleuroxus laevis, P. denticulatus, Disparalona hamata*, and others. Kotov et al. (2009) and Ishida et al. (2011) demonstrated presence of specific lineages of *Bosmina* (*Eubosmina*) and *Daphnia cf. galeata* in Japan. The chance of their presence in Korea is quite high. Sinev & Sanoamuang (2011) already presented evidence for a species status for *Disparalona cf. hamata* in SE Asia.

We believe that future revisions will demonstrate that at least some of them are groups of more locally distributed congeners. Especially interesting for such revisions are males, which provide valuable information for discrimination of close species (Kotov et al. 2009; Sinev & Sanoamuang 2011). Further studies re-evaluating knowledge on the Korean fauna will likely find an even stronger endemism than that found in the present communication.

Boreal-tropicopolitan pairs in Korea. The Korean Peninsula is located in the south Palaearctic (see map in Forró et al. 2008) and belongs to the Manchurian faunistic region of Wallace (1876). As a part of the East Asian monsoonal region, South Korea has a temperate climate with four seasons, winters are usually long, cold, and dry, whereas summers are short, hot, and humid; Seoul's mean temperature in January is -5° C to -2.5° C. The temperatures are higher along the southern coast, but even in Cheju Island, the southernmost point of Korea, average January temperature is only +2.5° C (Savada & Shaw 1990).

Yet, our study revealed some “tropical” taxa earlier un-recorded from Korean Peninsula and the Palaearctic. We were surprised to find such taxa as *Kurzia longirostris*, *Macrothrix triserialis* and *Camptocercus vietnamensis*, keeping in mind the “non-tropical” winter of Korea. So, we now classify the aforementioned taxa as “tropicopolitan” according to Schabetsberger et al. (2009, p. 158): "organisms that are frequently found throughout the tropical and subtropical zones (up to approx. 34ºN and S) but that do occur at higher latitudes, if local temperature regimes permit". Another such taxon is *Moinodaphnia macleayi*, already reported from south Japan (Mizuno & Takahashi 1991) and *Leberis diaphanus* described by Yoon (2010), but absent in our samples. Some other tropicopolitan taxa with a wide distribution penetrate north even deeper: *Pseudosida szalayi*, *Diaphanosoma orghidani trasamurensis*, *Scapholeberis kingi, Ephemeroporus barroisi*, *Ilyocryptus spinifer*, *I. cf. raridentatus, Disparalona hamata, Picripleuroxus cf. denticulatus* (Korovchinsky 2004, 2010; Kotov et al. 2011a,b).

It is a remarkable fact that we found in Korea some pairs of closest relatives, where the first taxon is tropicopolitan penetrating North, while the second taxon is boreal penetrating South: (*Macrothrix triserialis* - *M. rosea*, *Camptocercus vietnamensis* - *C. uncinatus*, *Leydigia ciliata* - *L. acanthocercoides*). So, Korea is a mixing ground of two faunistic complexes. Our observations at Bak Sil Ji wetland (see Table 1) revealed strong seasonal changes in species composition. Tropicopolitan species we found there in autumn, after a long hot and wet season, but in spring they were absent. At the same time, "Amur" endemic fauna was present only in spring, after a dry and cold winter.

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